2nd Mars 2020 Landing Site Workshop
August 4, 2015

Hypanis: A deltaic-lacustrine system at the edge of a Chryse sea?

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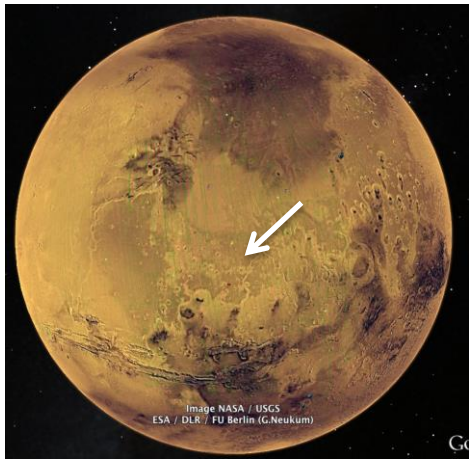
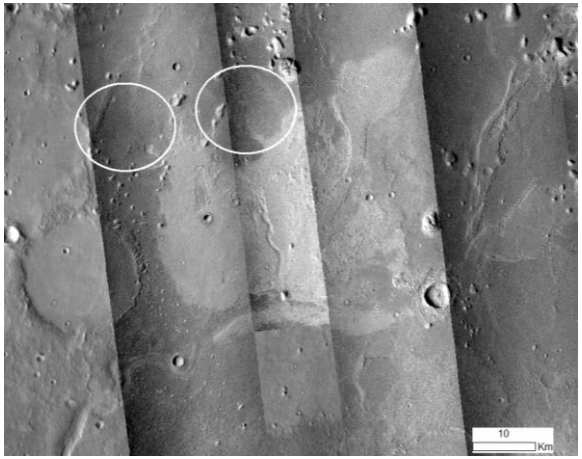
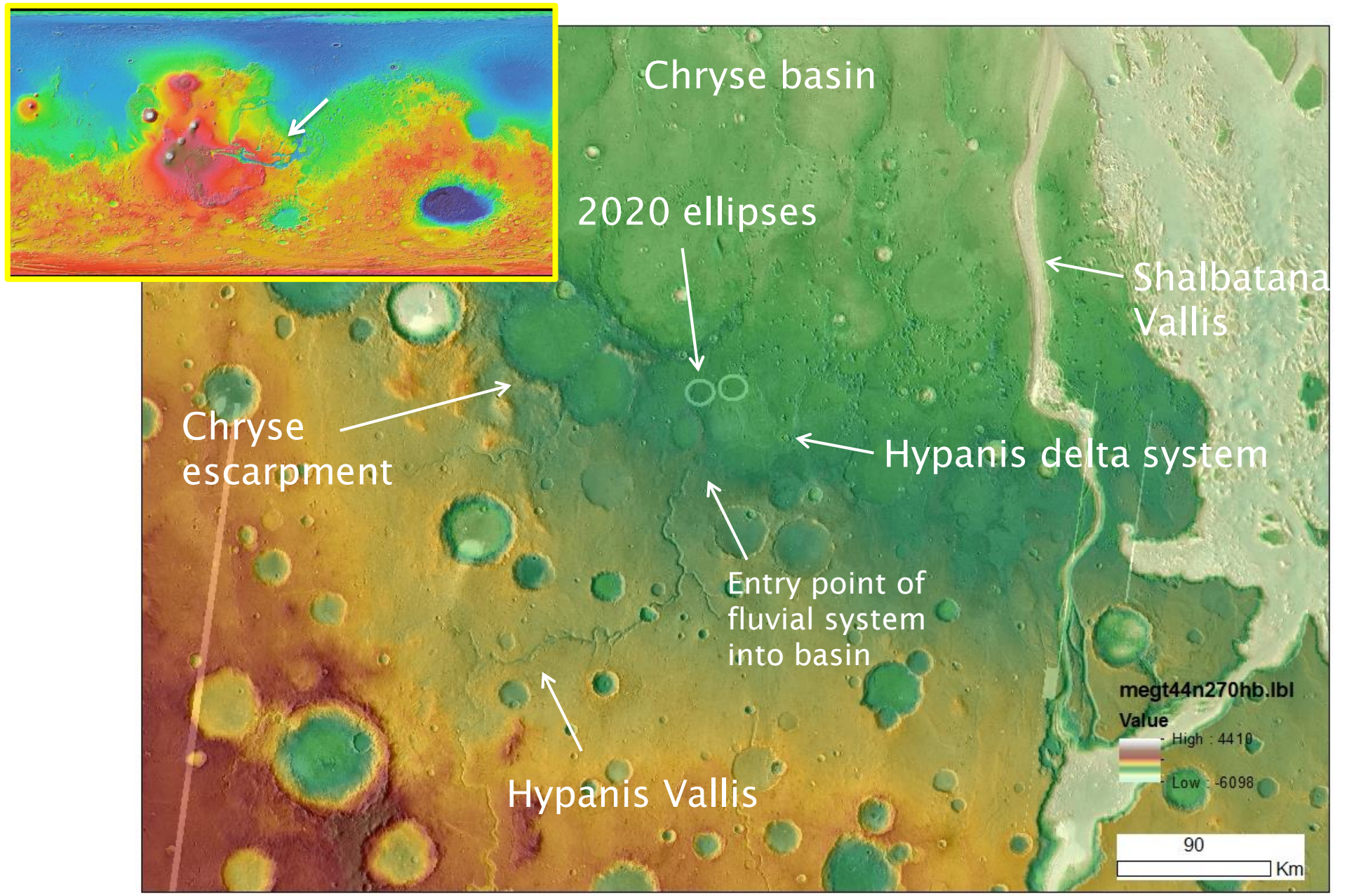
Thanks Jim Bell[2] for presenting!





[1]Olde Englanders
[2]New Englander

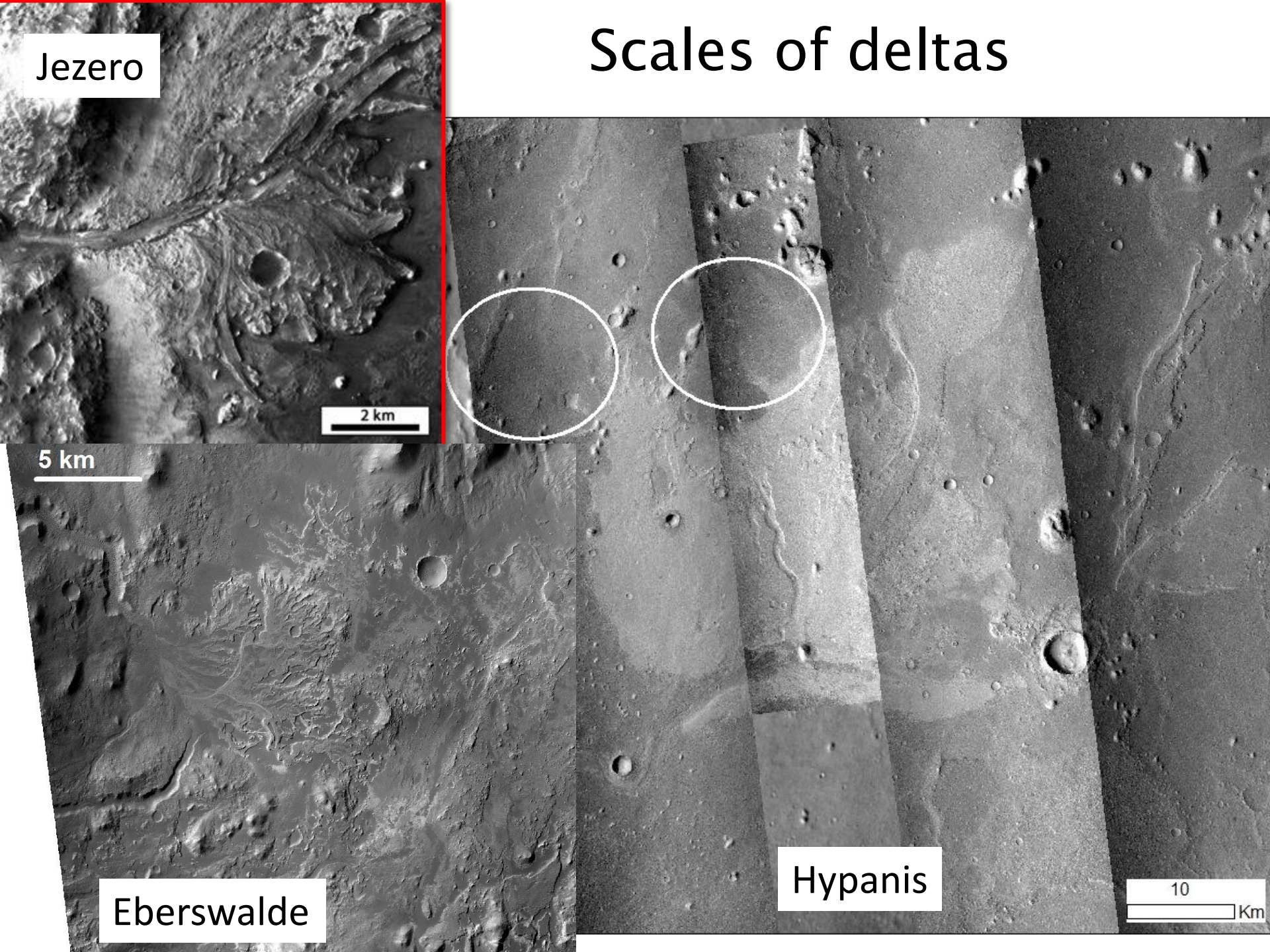
MOLA Topography: Overview location of Hypanis system in Xanthe Terra



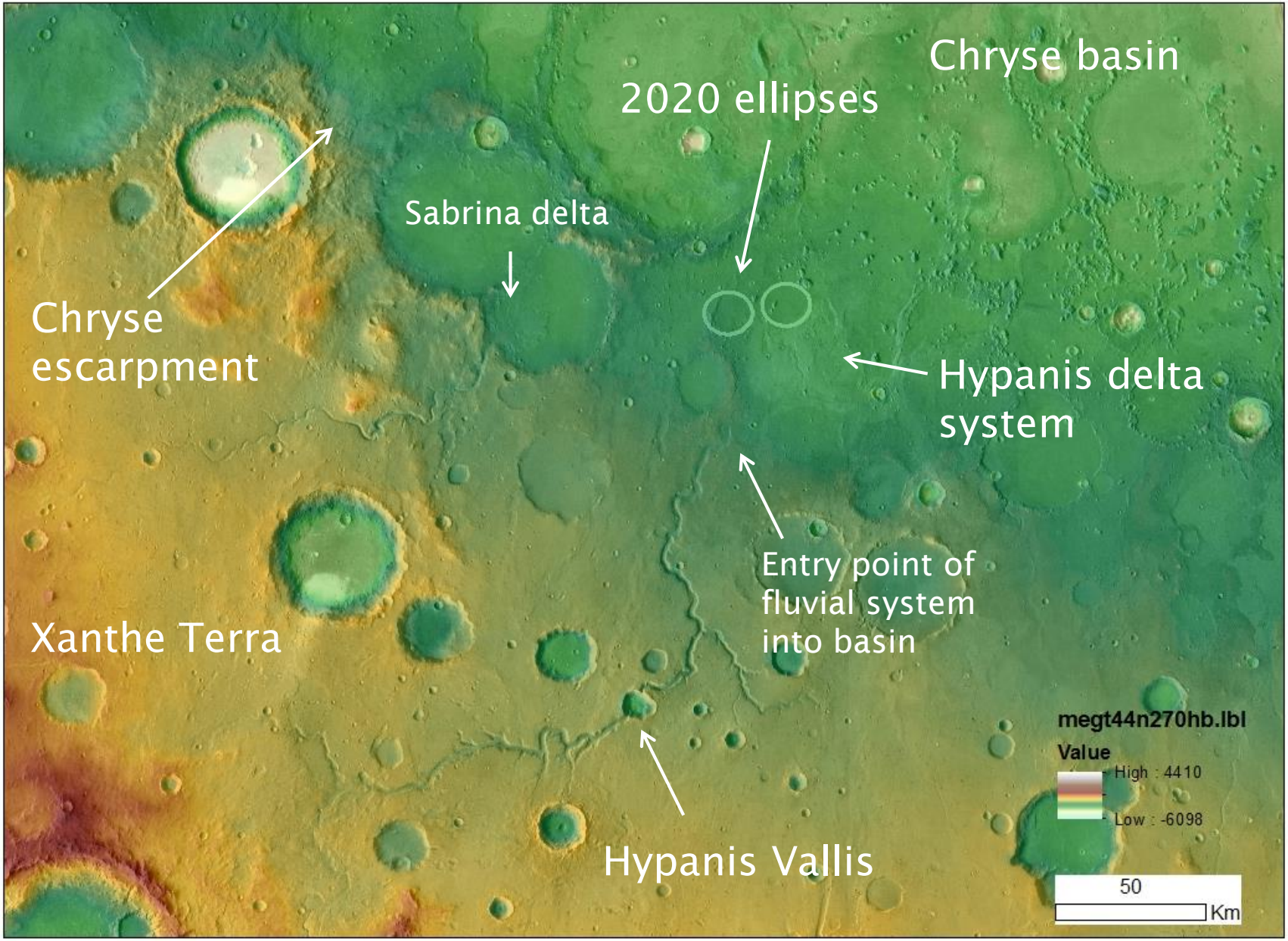
Source of Hypanis

- **Hypanis fan system is fed by a very extensive bedrock valley – Hypanis Vallis – several hundred kilometres long (?), ~75 m deep**
- **Valley network is very different to drainages sourced from crater rims cf. Gale crater fan and other crater-rim fed fans**
- **Hypanis is a much bigger system**
- **Hypanis and Sabrina deltas are located at margin of Chryse escarpment – abrupt transition from erosional to depositional realm**
- **Timescale of fluvial erosion**
  - **Valley form is different to outflow channels**
  - **Narrow width, sinuous valley form**
  - **Suggests long-lived erosion – not instantaneous or short-lived erosion**

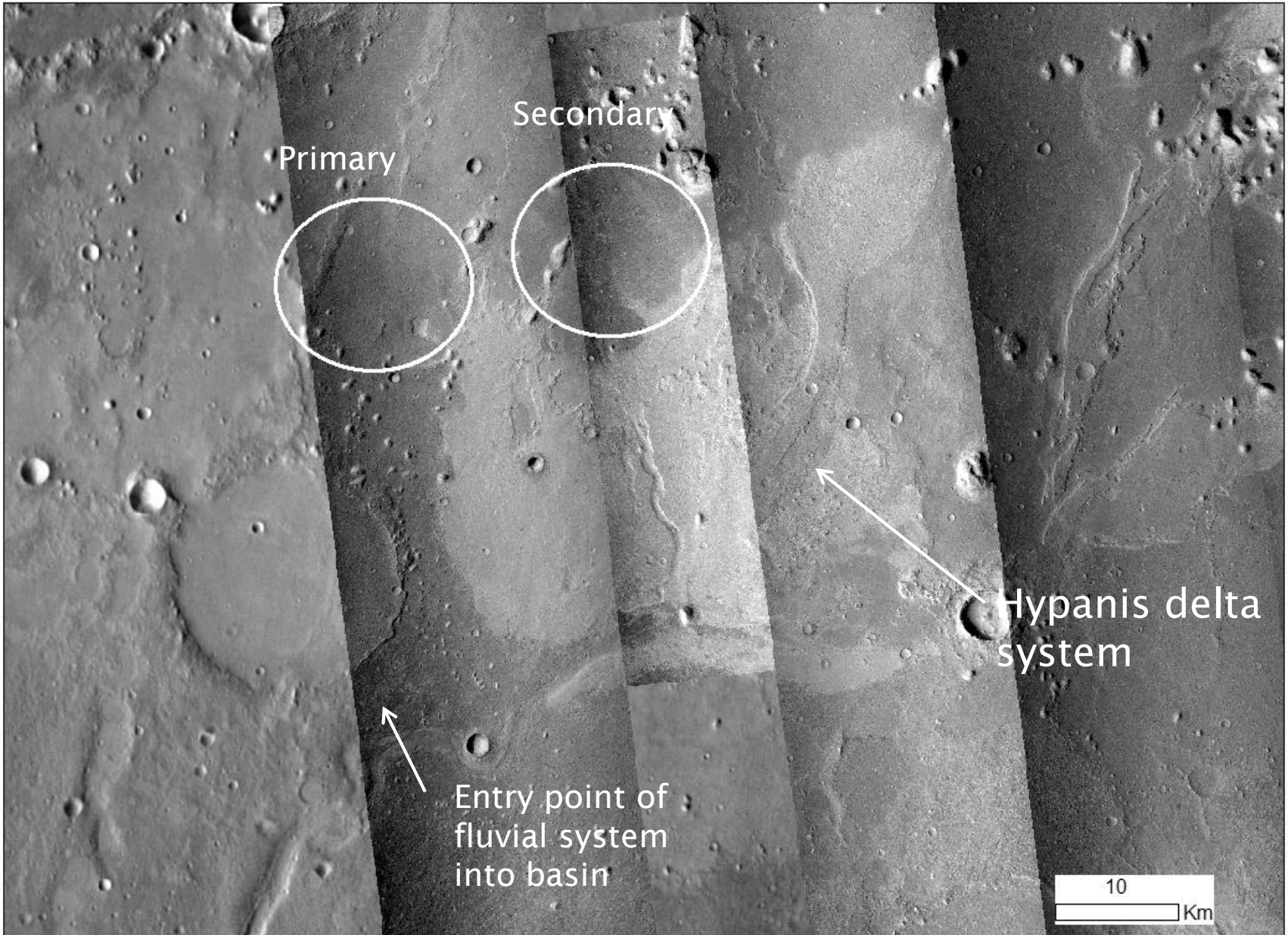
Scales of deltas



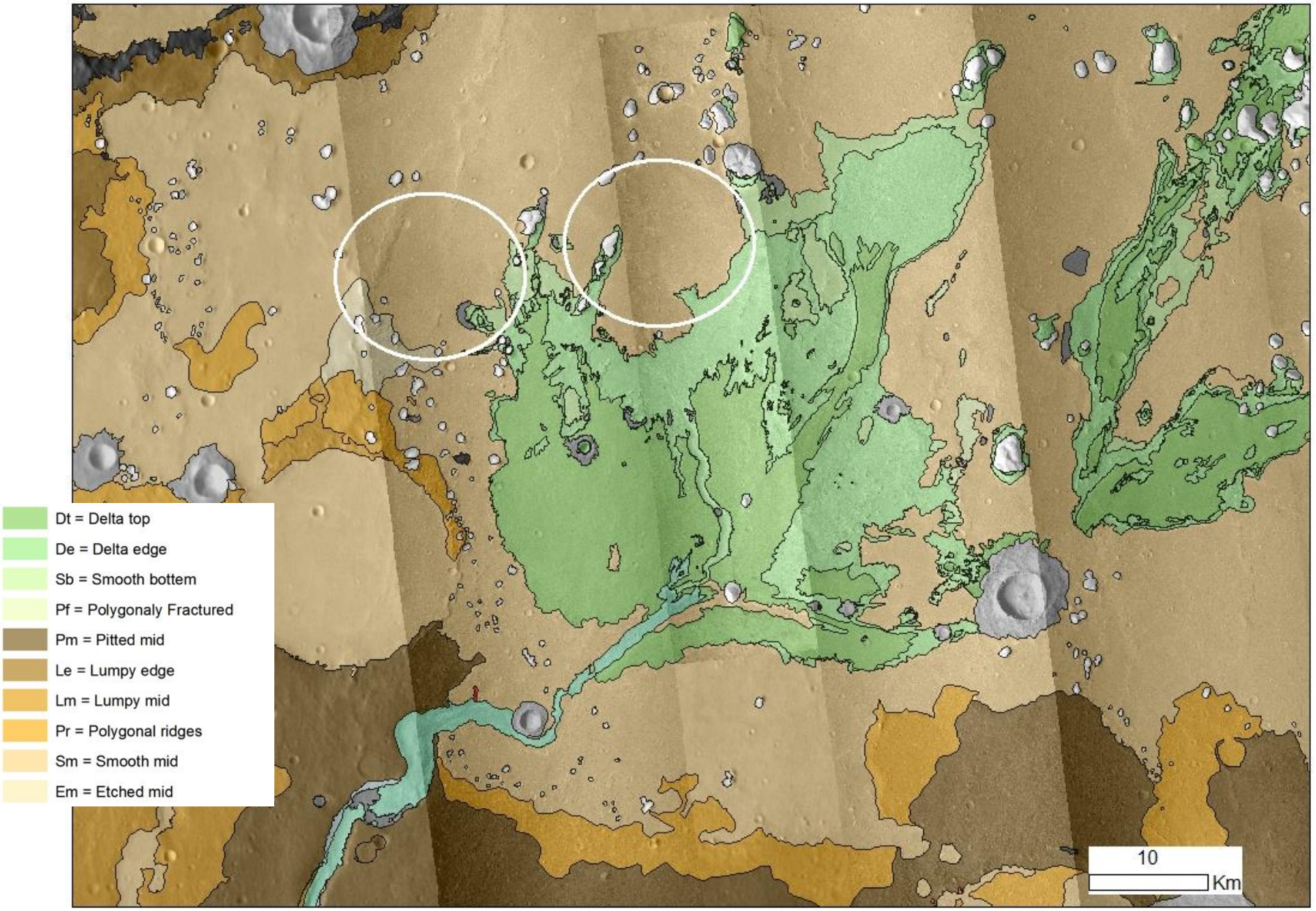
Hypanis has a large catchment!



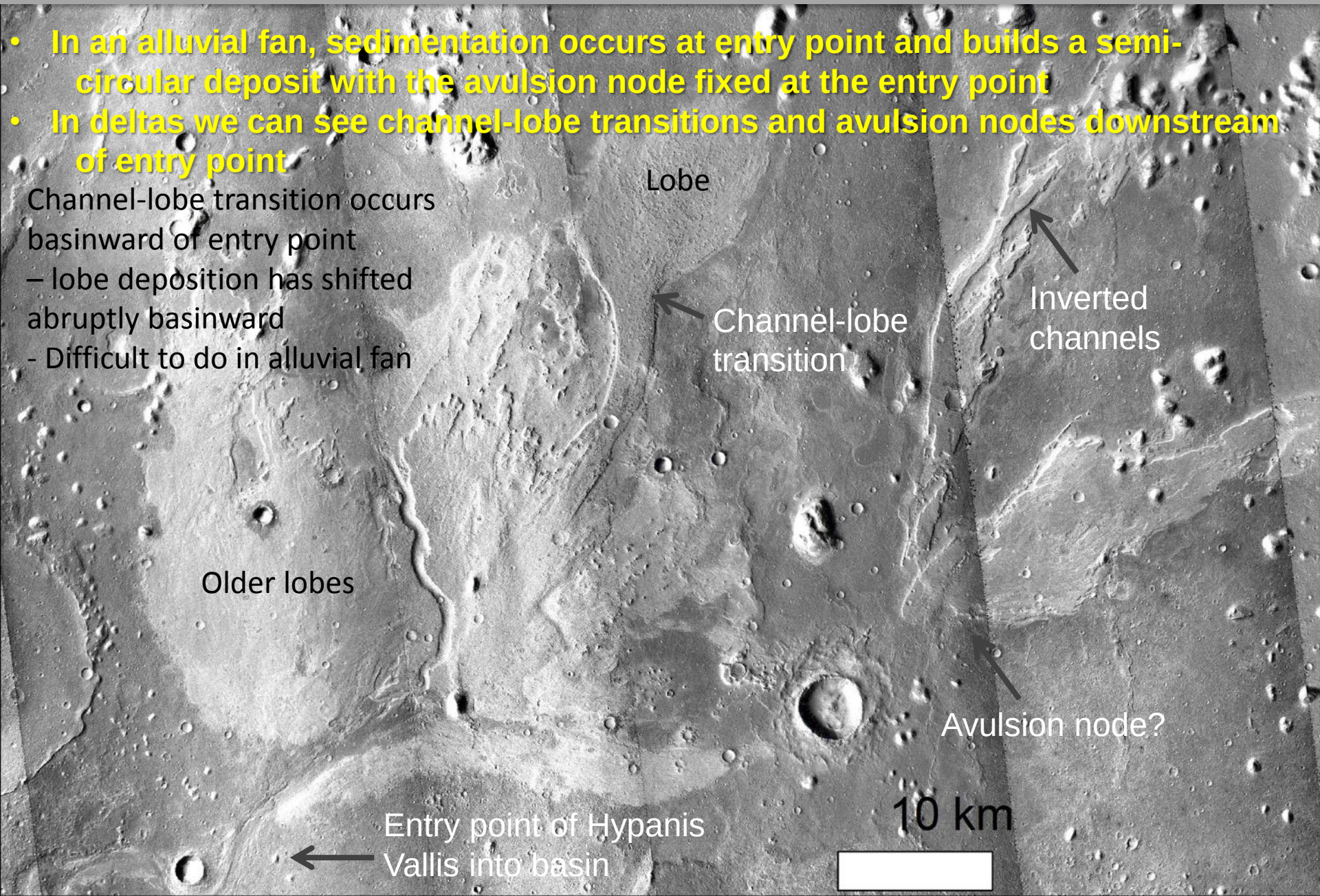
Location of possible ellipses relative to delta

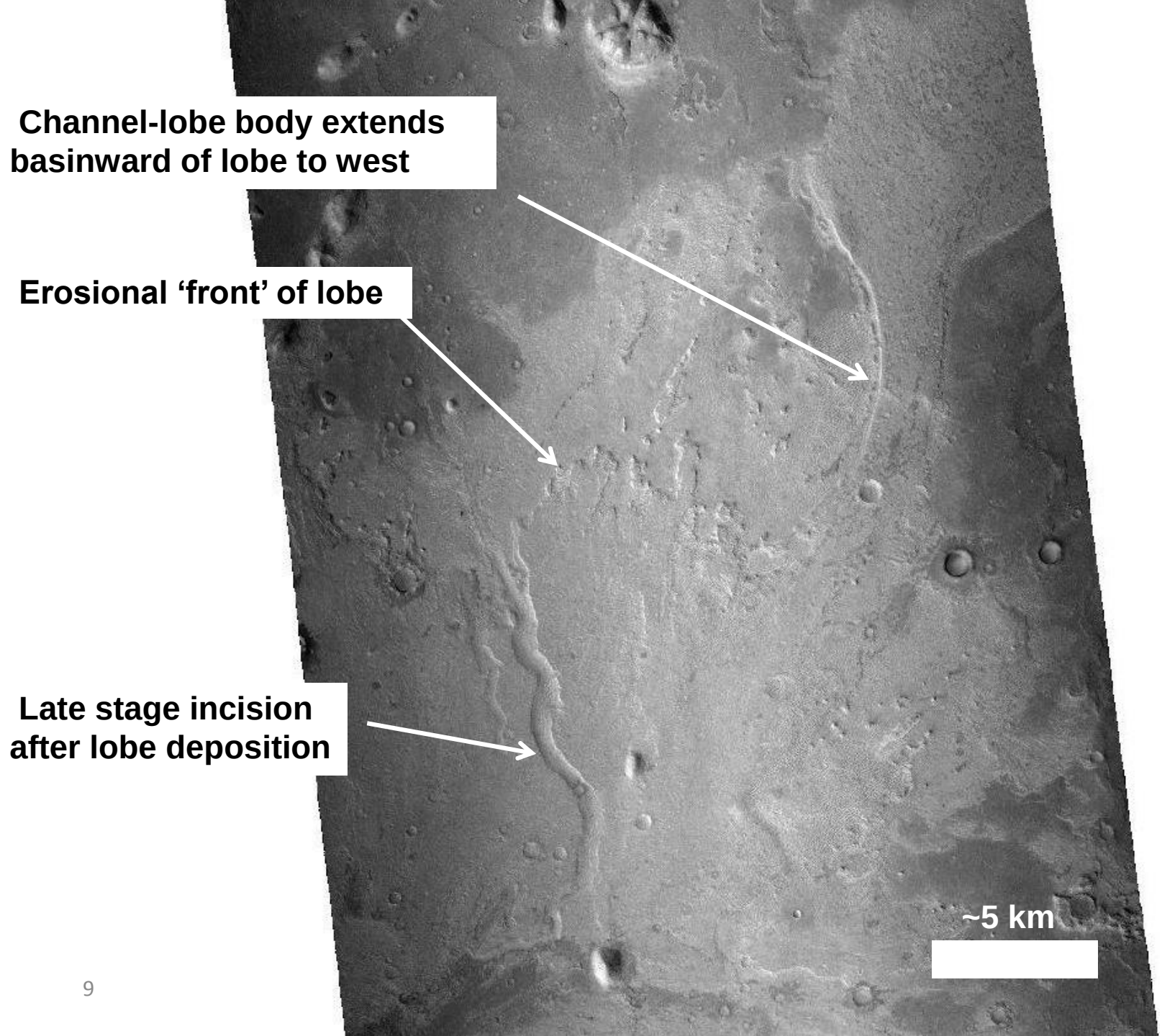


Geological map of deltaic units



Hypanis – why is it a delta and not an alluvial fan?




Channel-lobe body extends basinward of lobe to west
Erosional 'front' of lobe
Late stage incision after lobe deposition
~5 km

Large-scale geometry of the Hypanis system

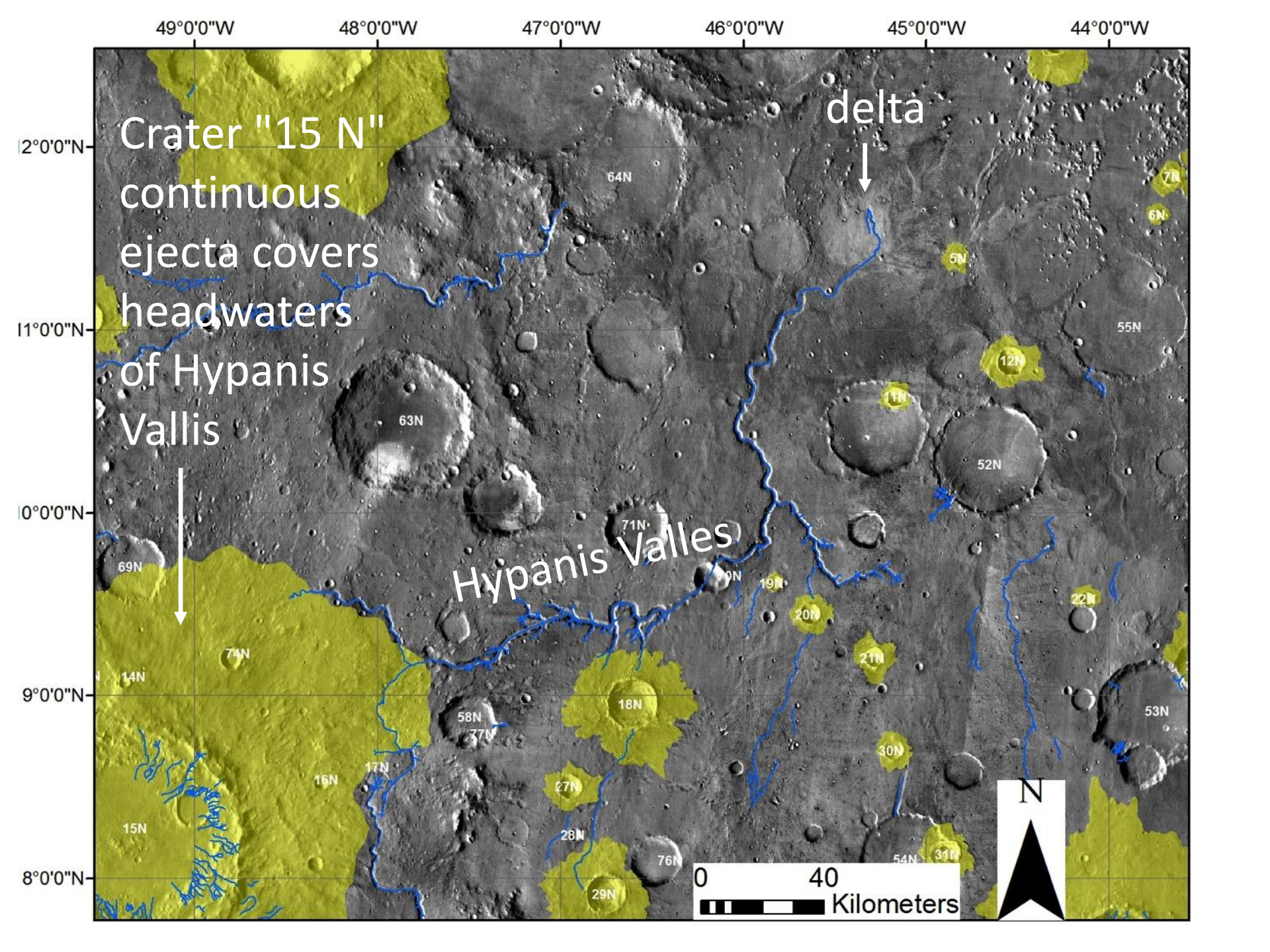
- **Hypanis system comprises multiple depositional lobes**
- **Individual lobes appear to cross-cut each other**
- **=> we observe temporal variation in deposition – lobes are shifting sideways through time – this is classical behaviour – called compensation cycles**
- **Channel-lobe features appear to shift basinward**
  - **System progrades basinwards…**
- **In eastern part of ellipse, we observe long, inverted channel system extending beyond termination of central lobe**
  - **Does this indicate further basinward progradation of fluvial systems?**
  - **Maybe an overall progradational system.. Would prograde over finer-grained basinal lower energy deposits**

Age of Hypanis deposits

Nick Warner + students at SUNY Geneseo

Crater Counts on Deltas?

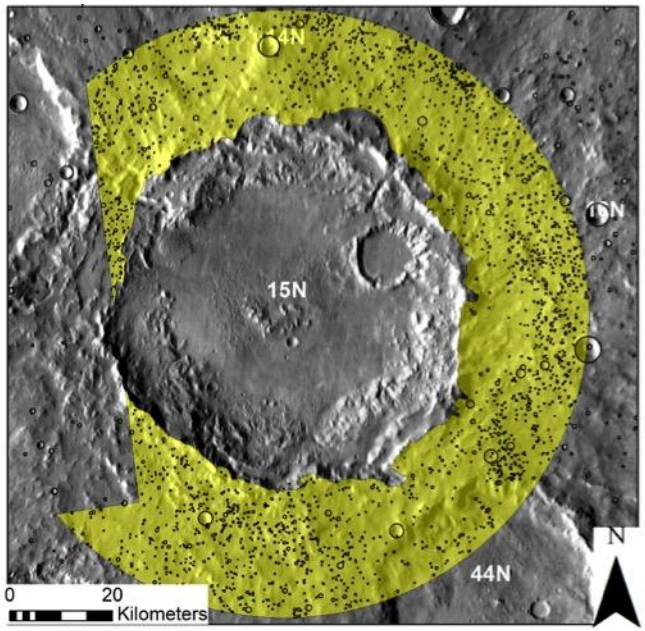
- Crater counting directly on deltas in Xanthe Terra (e.g. Hypanis Delta) has major limitations.
- Warner et al. (2015) (limitations of small area counts).
- Area of typical deltas = $10^1 – 10^2$ km^2, too small for accurate crater counting given (1) crater resurfacing and (2) the spatial variability of cratering as a random process.
- Deltas in this region show evidence for significant resurfacing (inverted landforms, isolated layered mesas and buttes, degraded craters) and do not preserve craters well.
- Another more regional method of dating is required.

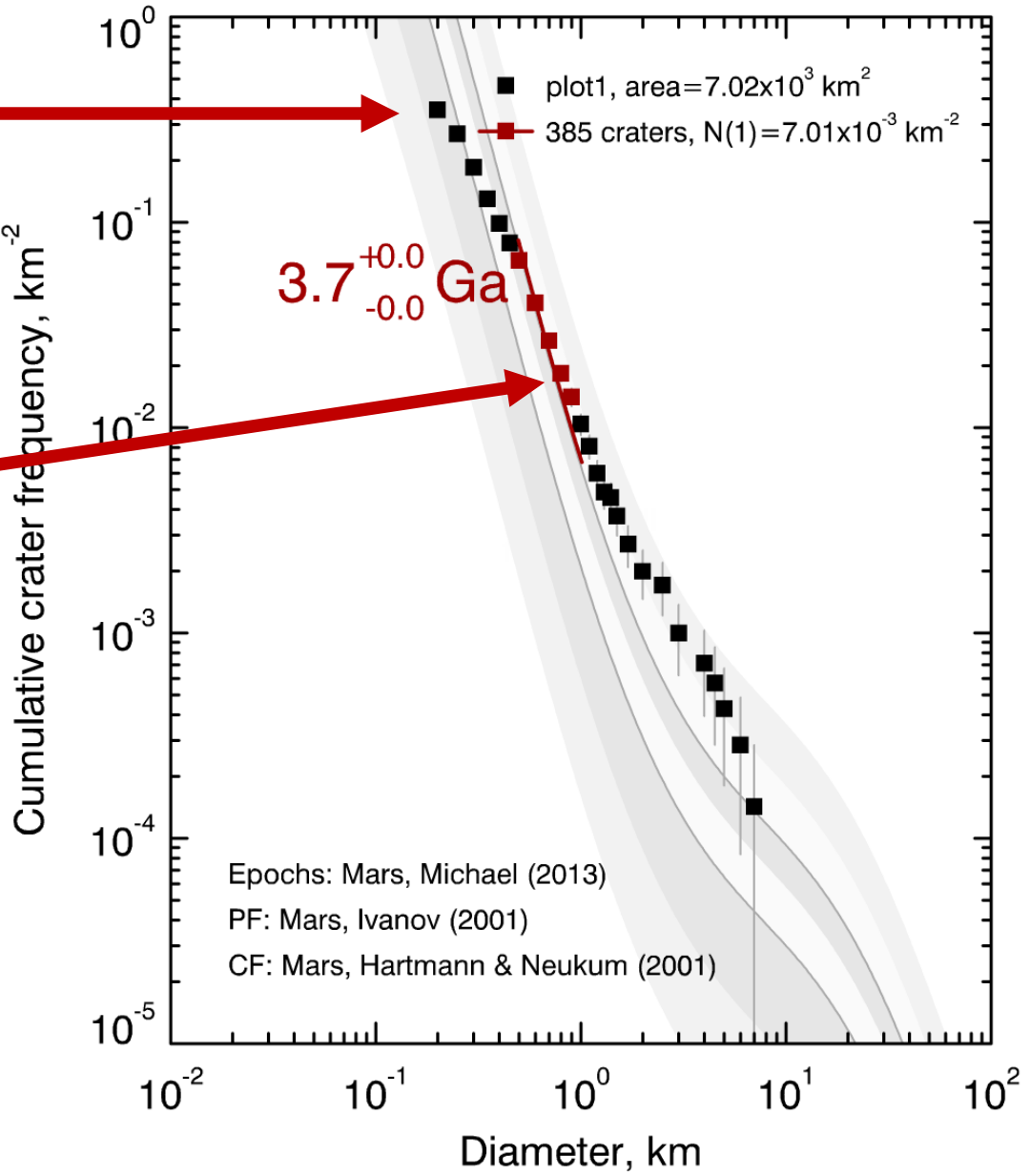

49°0'0"W
48°0'0"W
47°0'0"W
46°0'0"W
45°0'0"W
44°0'0"W
12°0'0"N
11°0'0"N
10°0'0"N
9°0'0"N
8°0'0"N
Crater "15 N" continuous ejecta covers headwaters of Hypanis Vallis
delta
Hypanis Valles
64N
63N
71N
69N
74N
14N
58N
37N
18N
16N
17N
15N
27N
28N
76N
29N
7N
6N
5N
55N
12N
11N
52N
19N
20N
22N
21N
53N
30N
54N
31N
0
40
Kilometers
N

Crater 15N Ejecta Crater Count

200 – 500 m, slope lower than SFD (poor preservation)

Fit is to 500 m to 1 km



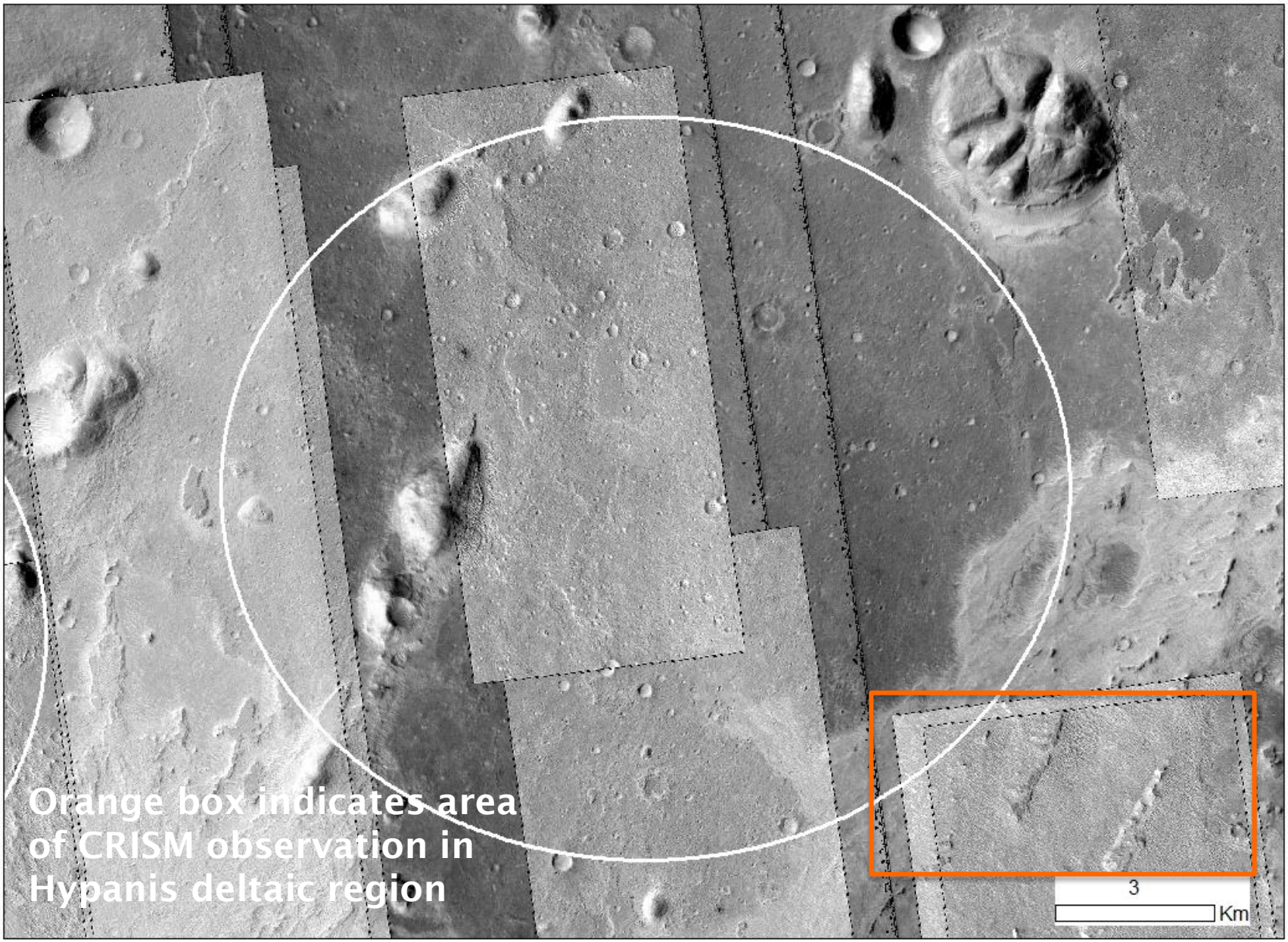


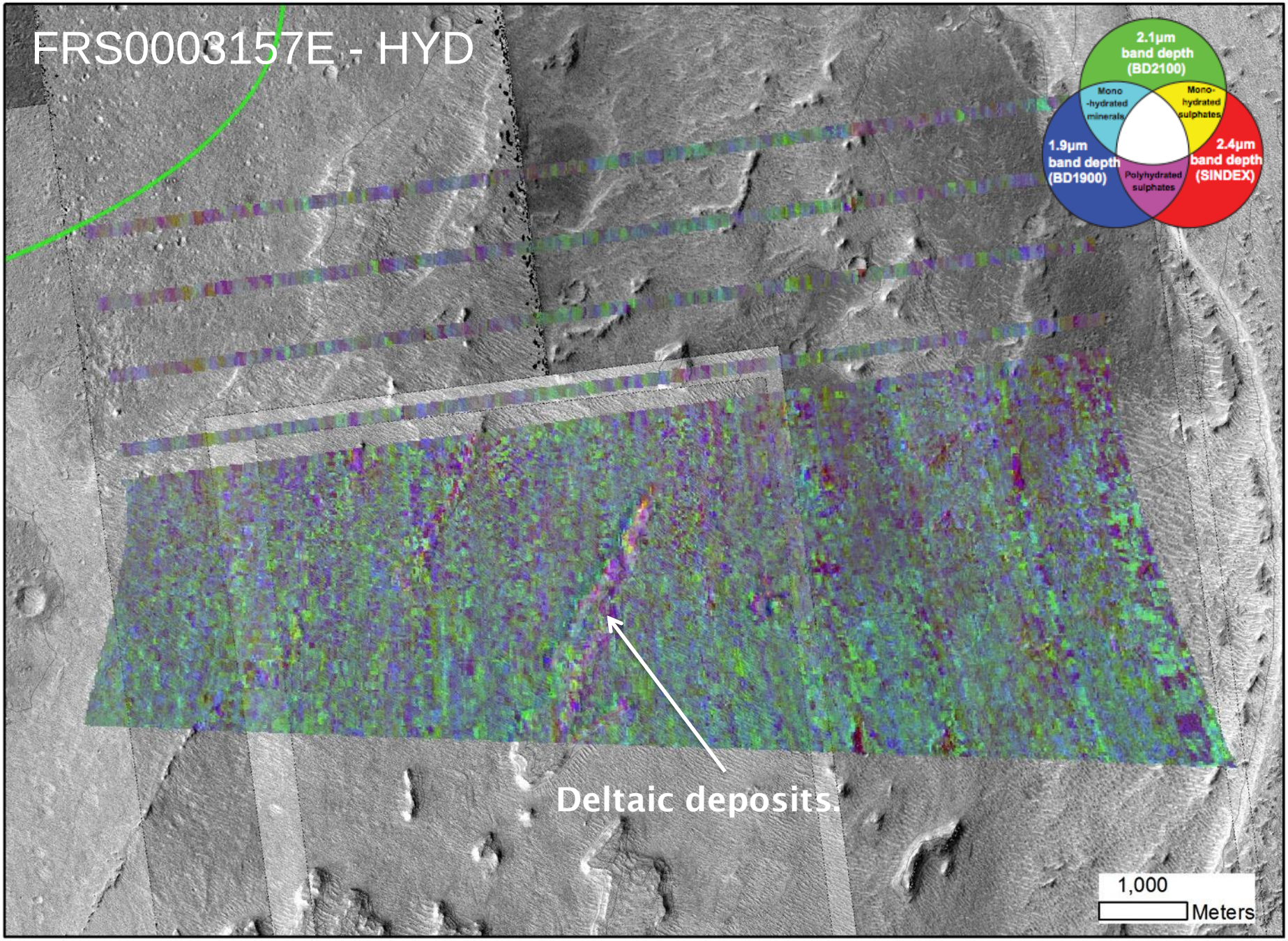
Hypanis Vallis Relative Age

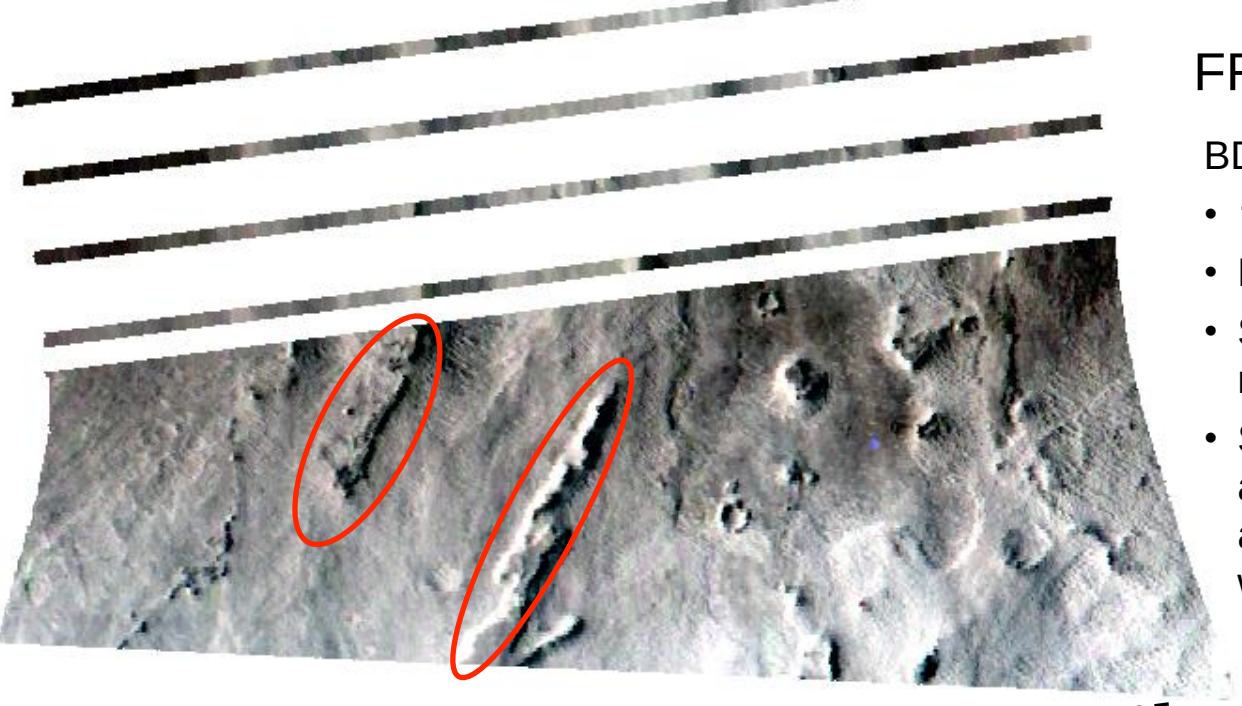
Hypanis Valles older than crater 15N

- Ejecta crater count = 3.7 Ga
- Crater degradation data: 15N is 80% from pristine d/D (≤ 3.6 Ga)
- Hypanis Valles is likely Early Hesperian or older

Orbital mineralogy – very limited data



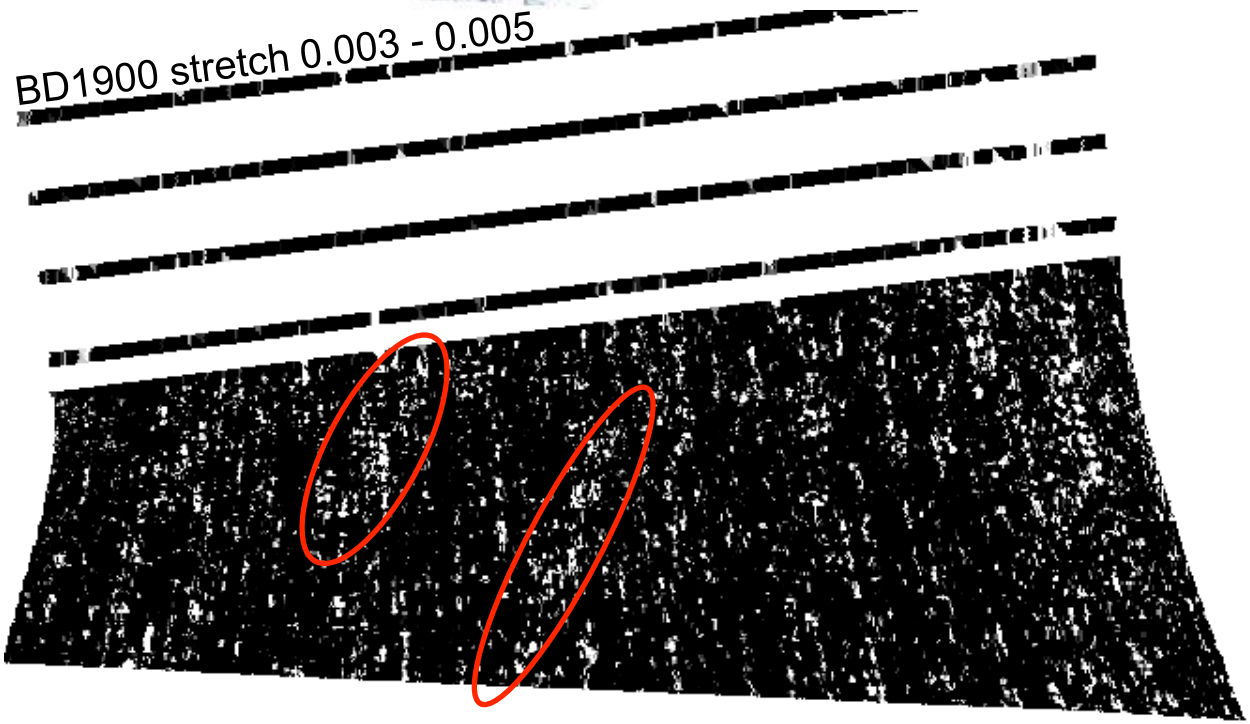

FRS0003157E - HYD
2.1µm band depth (BD2100)
Mono -hydrated minerals
Mono-hydrated sulphates
1.9µm band depth (BD1900)
Polyhydrated sulphates
2.4µm band depth (SINDEX)
Deltaic deposits
1,000
Meters



FRS0003157E

BD1900

- 1.9μm due to bound molecular H_2O
- Remnants of delta material.
- Signal on order of highest amplitude noise, but is spatially significant.
- Signal aligns with geologic units and appears to occur at different phase angles, therefore not just correlation with illumination conditions.



Ongoing analysis to statistically quantify spatial correlation with geologic units.

CRISM Summary

3157E

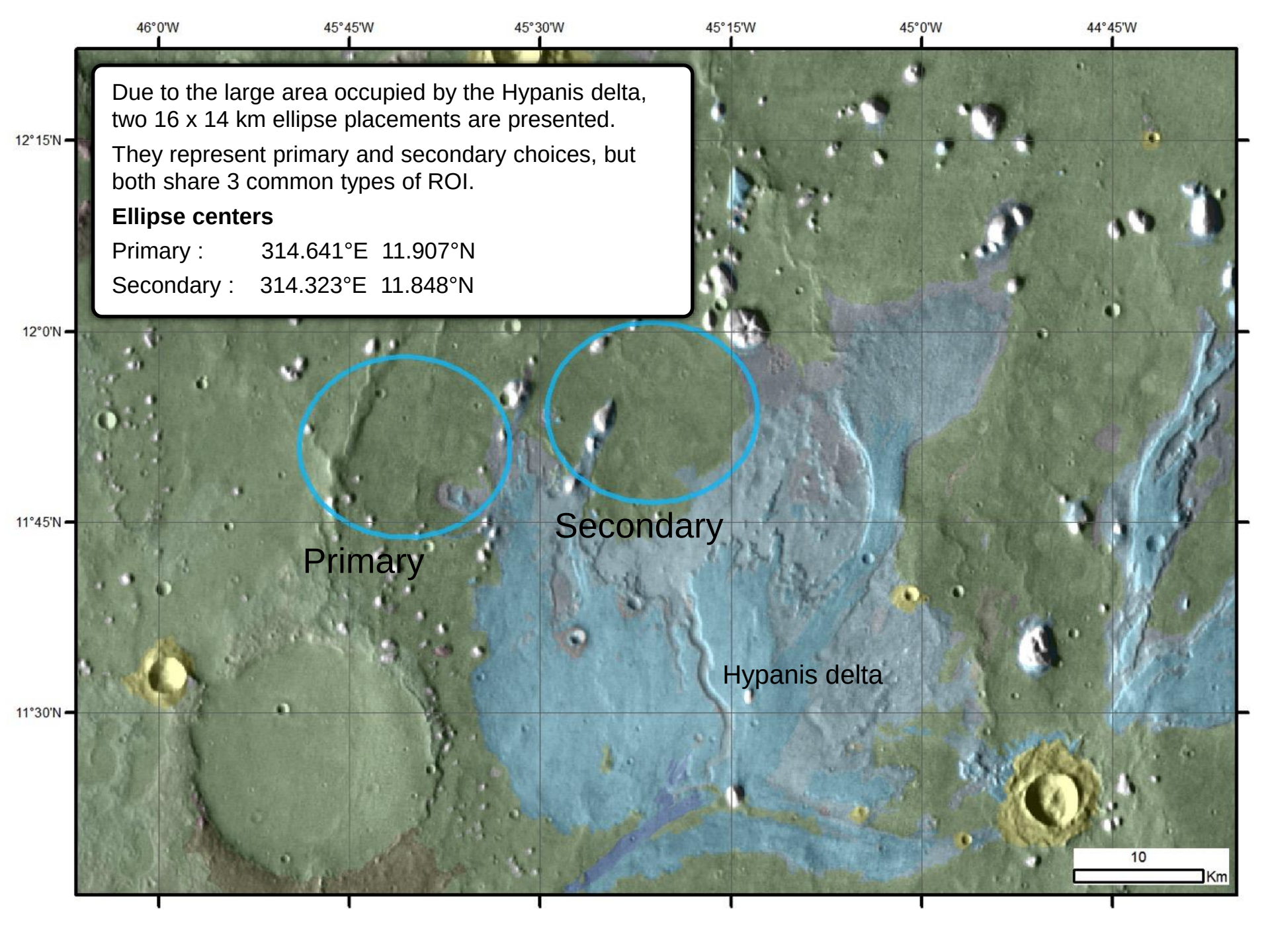
- Limited data near ellipses
- Hydration in northern reaches of Hypanis delta material, at contact between delta edge (De) and delta top (Dt) units.
- Detailed analysis ongoing to reconcile spatial alignment of signal with stratigraphy.

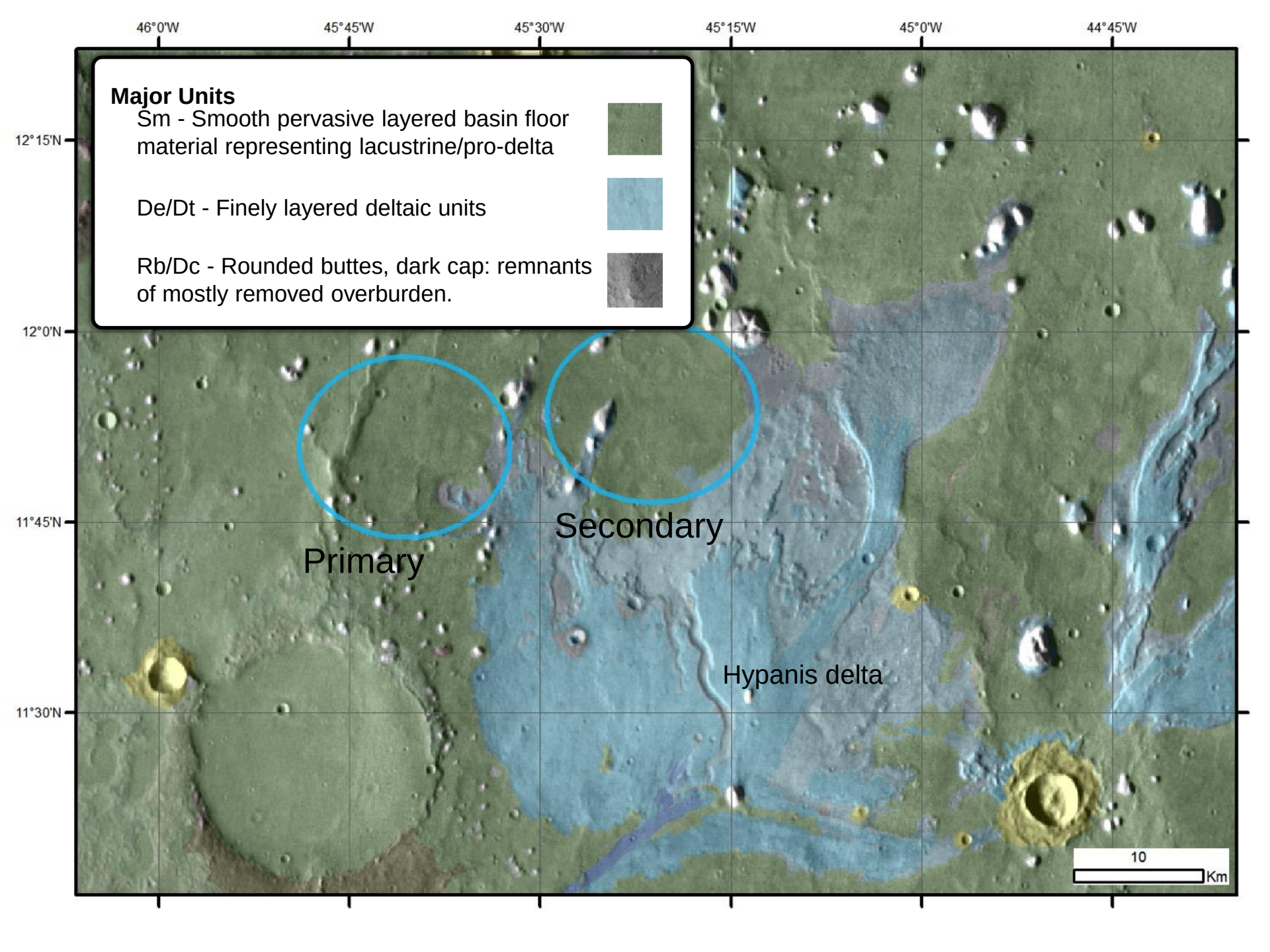
EXTRA

3134F - outside ellipse but in region

- Indicates Fe/Mg-phyllosilicates in ‘Le’ unit near Magong crater rim.
- Spatially coincident with fractured surface texture.

HYPANIS ROIs

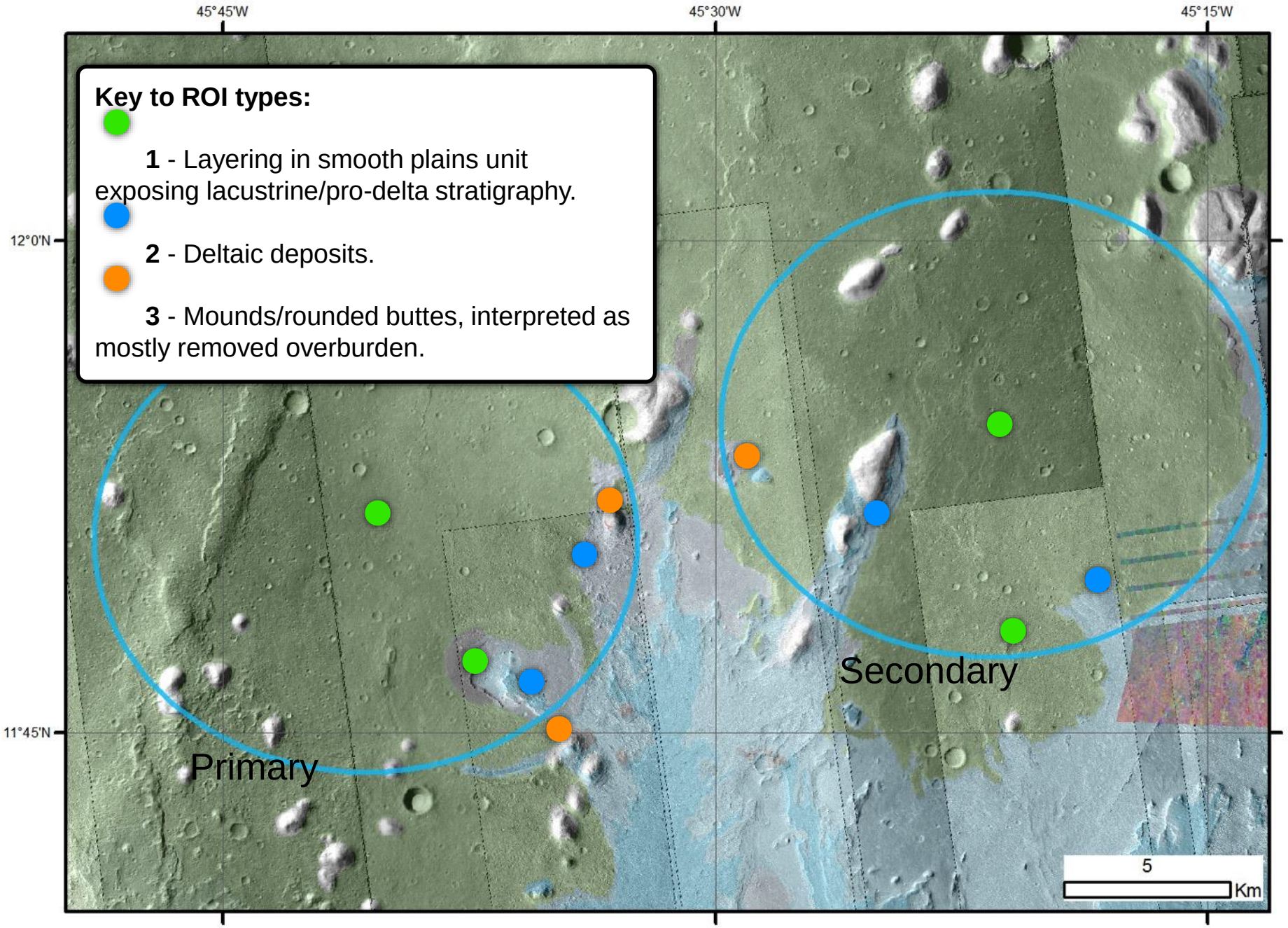

46°0'W
45°45'W
45°30'W
45°15'W
45°0'W
44°45'W
12°15'N
12°0'N
11°45'N
11°30'N
Due to the large area occupied by the Hypanis delta, two 16 x 14 km ellipse placements are presented.
They represent primary and secondary choices, but both share 3 common types of ROI.
Ellipse centers
Primary : 314.641°E 11.907°N
Secondary : 314.323°E 11.848°N
Primary
Secondary
Hypanis delta
10
Km


46°0'W
45°45'W
45°30'W
45°15'W
45°0'W
44°45'W
12°15'N
12°0'N
11°45'N
11°30'N
Major Units
Sm - Smooth pervasive layered basin floor material representing lacustrine/pro-delta
De/Dt - Finely layered deltaic units
Rb/Dc - Rounded buttes, dark cap: remnants of mostly removed overburden.
Primary
Secondary
Hypanis delta
10
Km

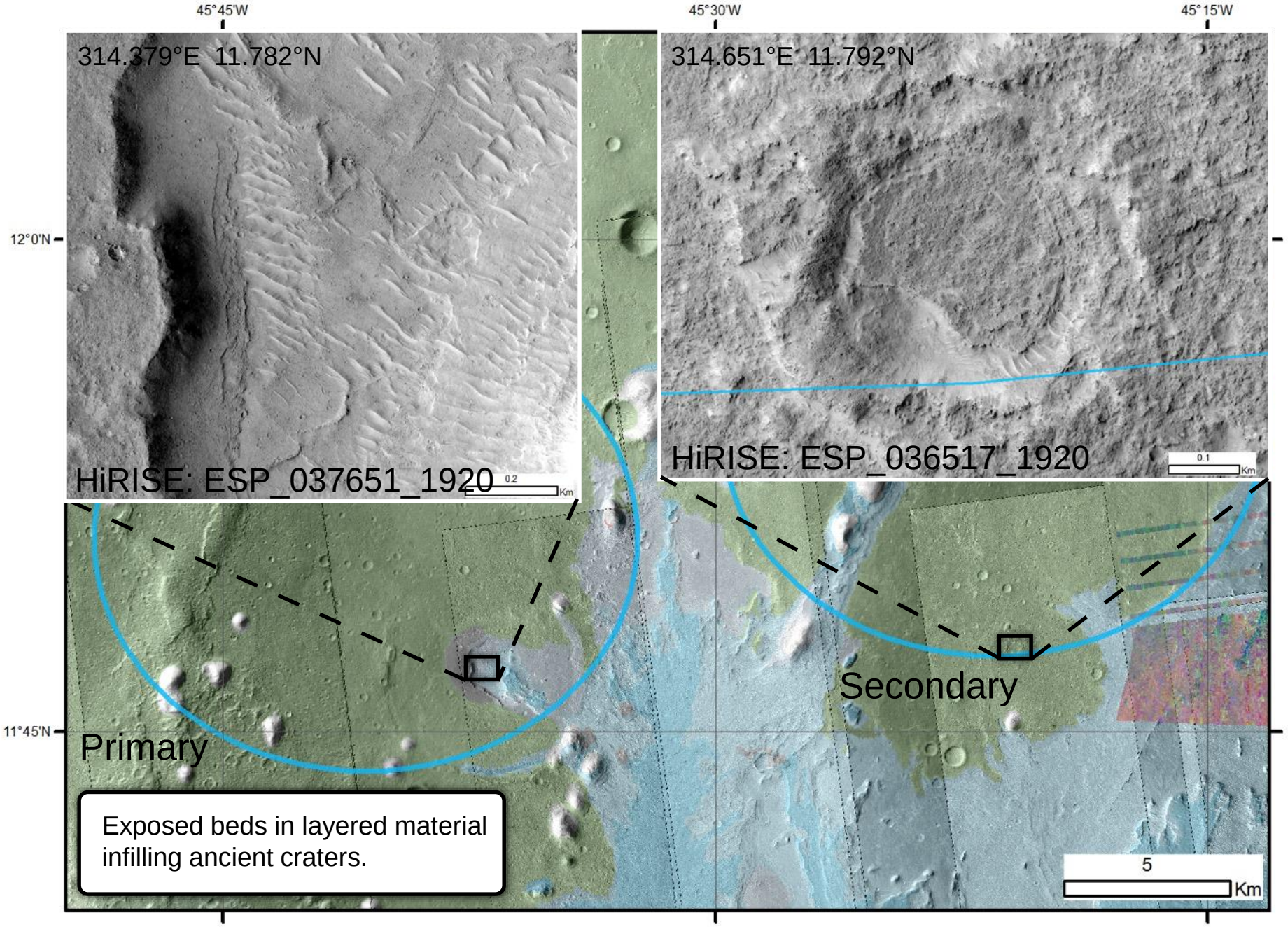
Meeting Mars 2020 Science Criteria

Objective	Relevant ROIs	Rationale
A: Characterize geology of astrobiologically relevant area.	1-3	Sedimentological and geochemical analyses of distal delta deposits and pro-delta material in multi-episodic fluvial system with extensive source region.
B: Determine habitability and biosignature preservation potential.	1-3	Recent removal of overburden material, preserving exhumed deposits laid down in near-neutral aqueous environment. Phyllosilicates in basin floor material and hydration in delta deposits.
C: Caching of scientifically selected and compelling samples.	1,2	Potential samples: • Clay-bearing lacustrine pro-delta material (2.3μm in CRISM FRS0003134F). • Hydrated deltaic deposits (1.9μm in CRISM FRS0003157E). • Volcanic(?) overburden material.

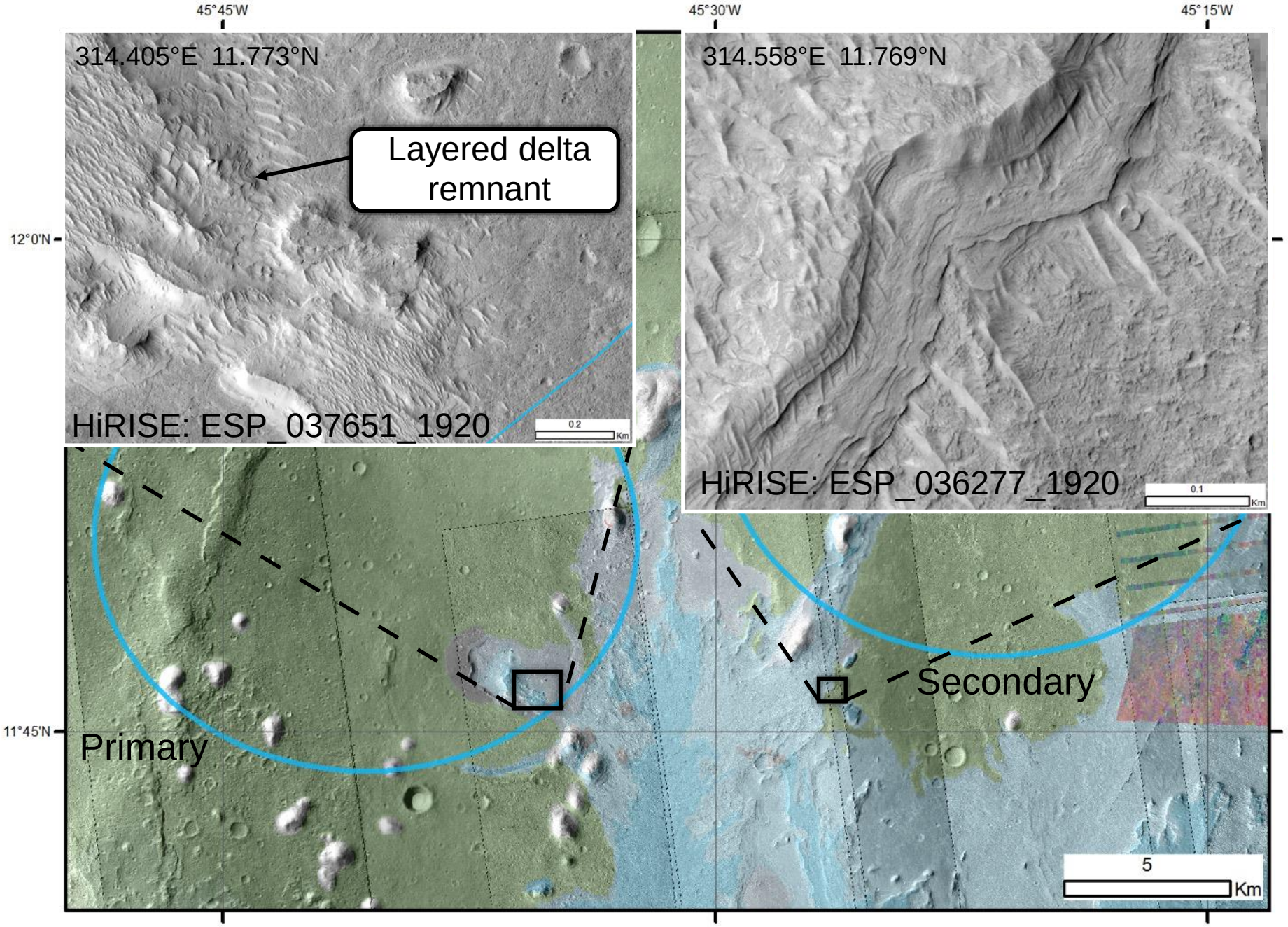
ROI type 1: Basin floor material/lacustrine pro-delta



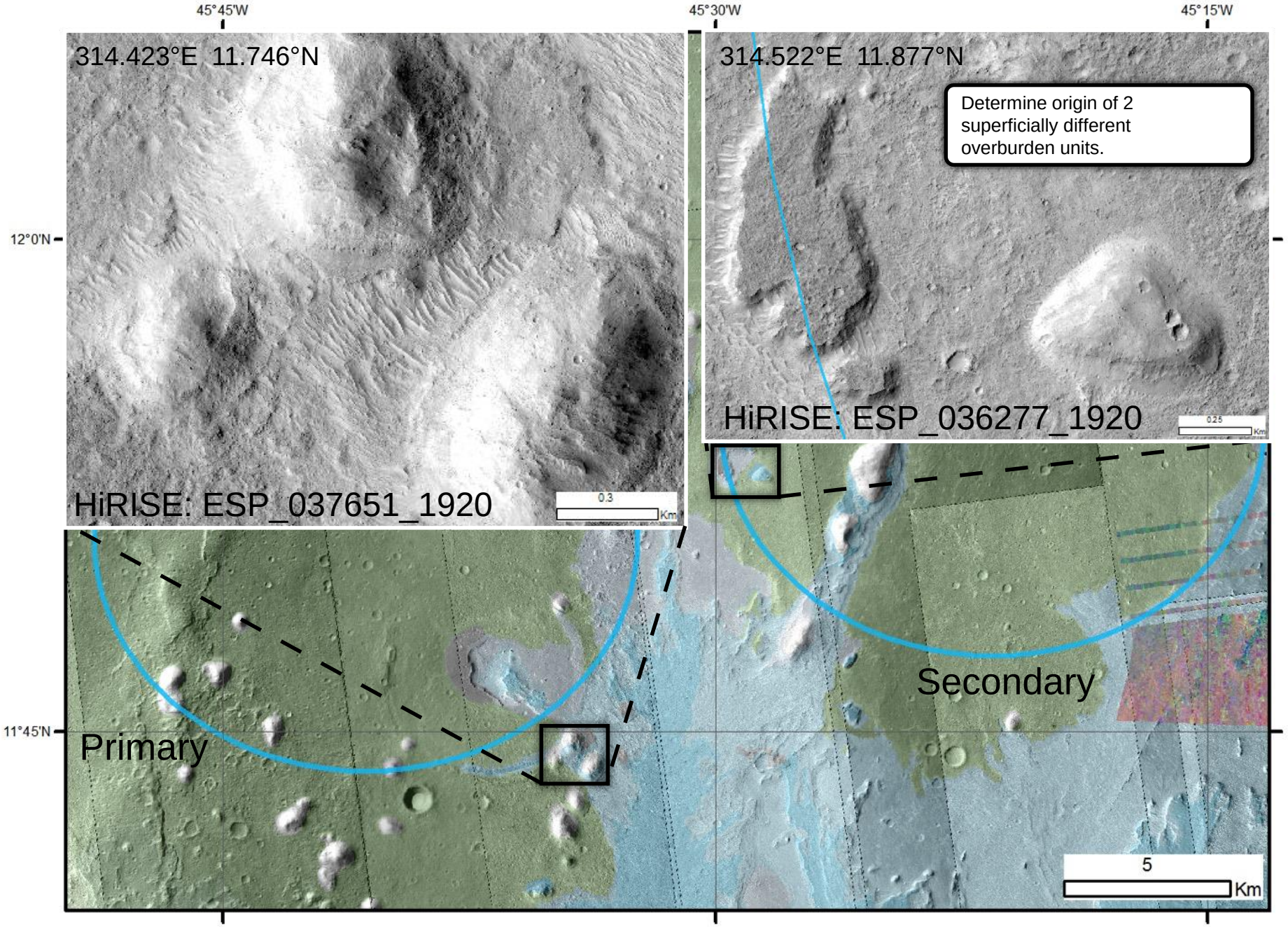
ROI type 1: Basin floor/lacustrine pro-delta material



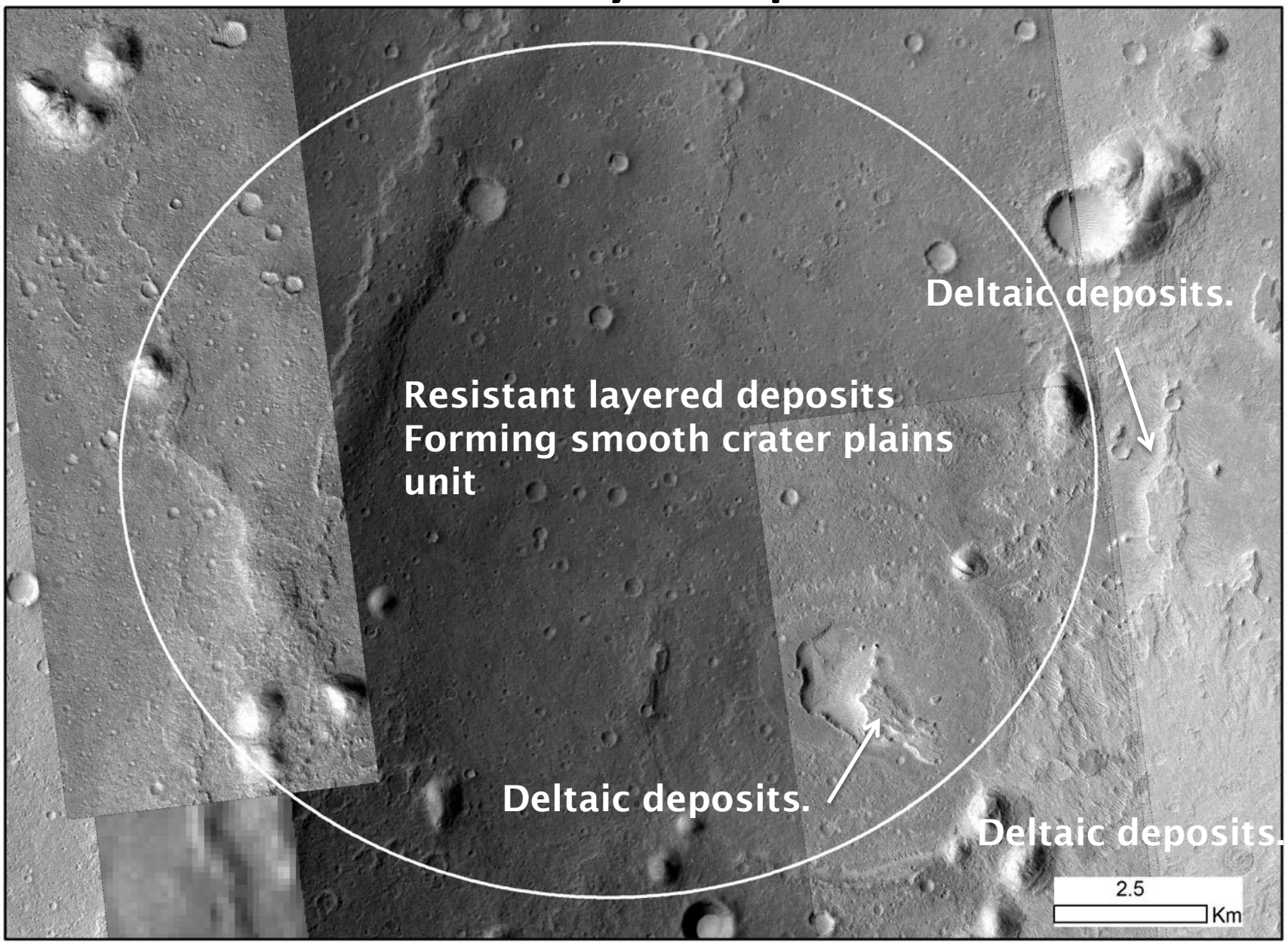
ROI type 2: Deltaic deposits



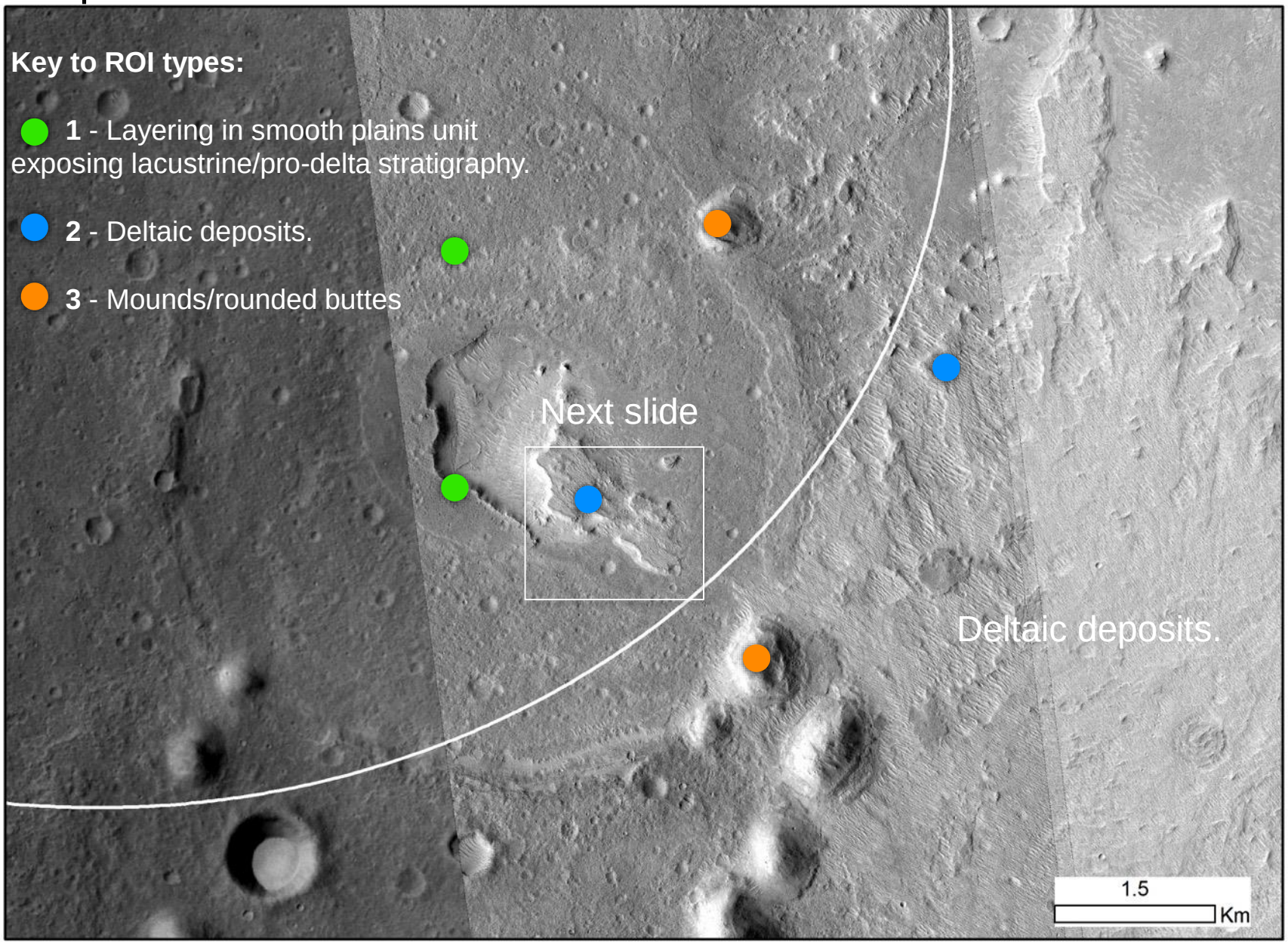
ROI type 3: Rounded buttes/overburden material



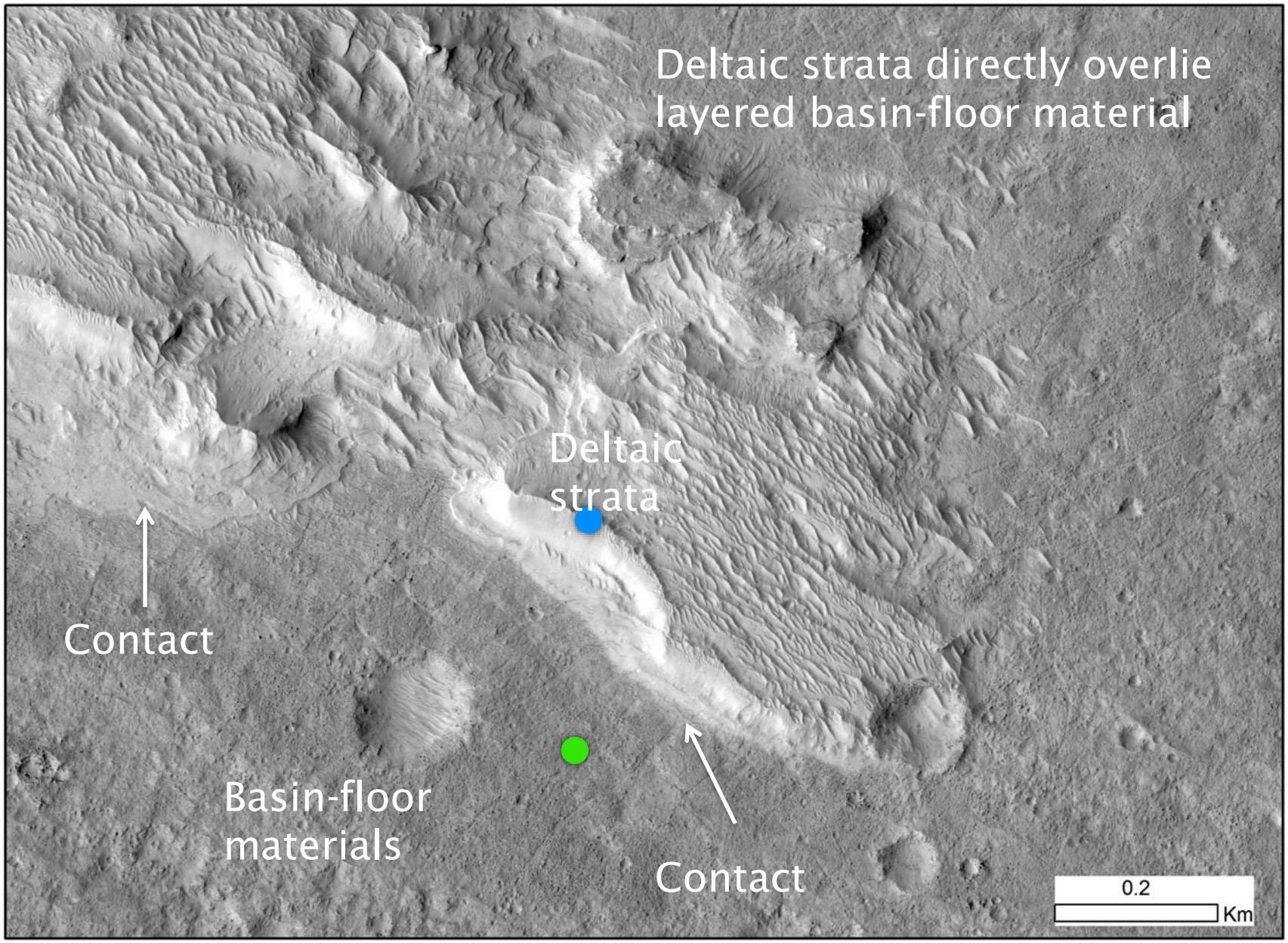
Primary Ellipse

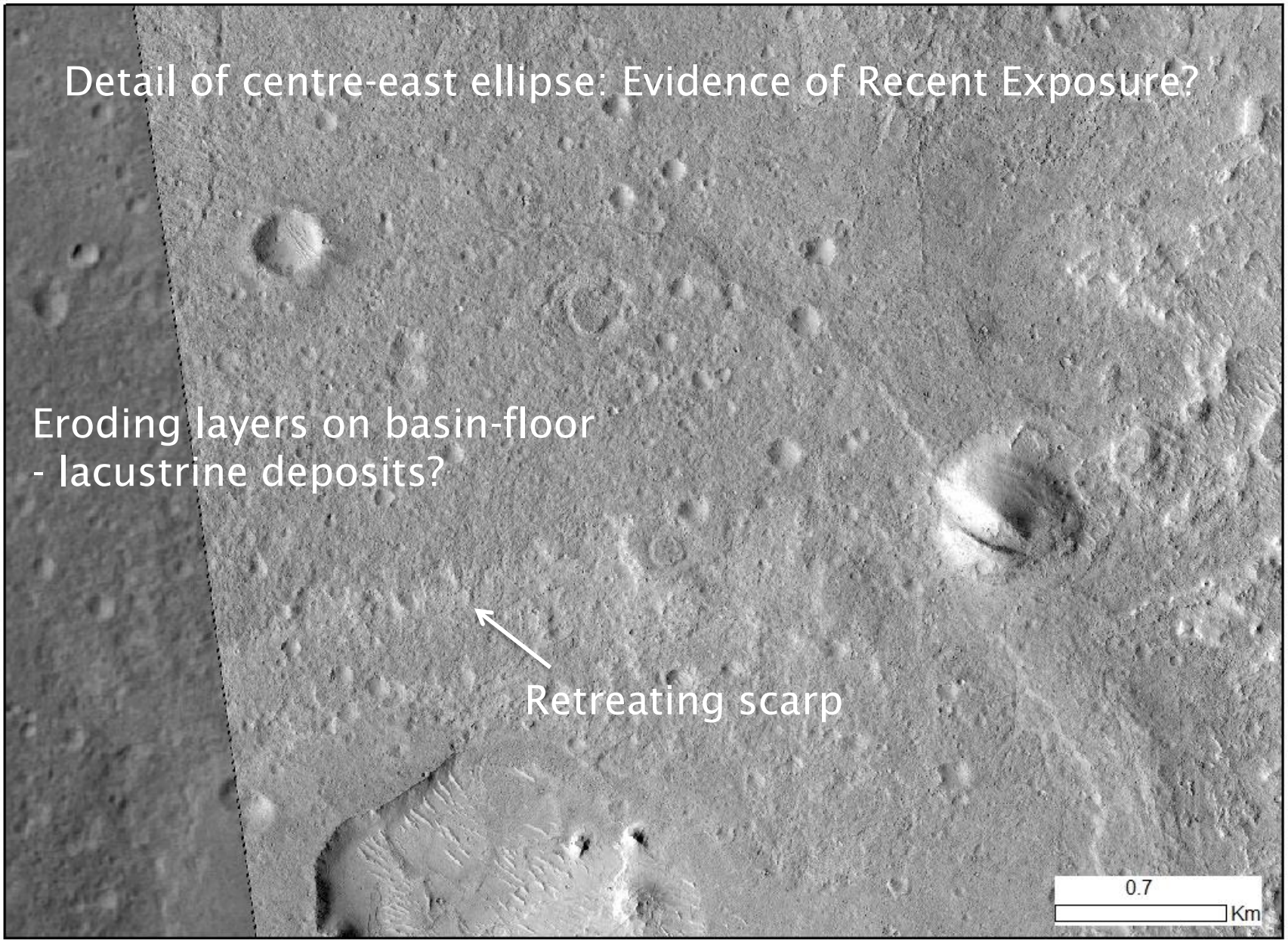


SE Ellipse

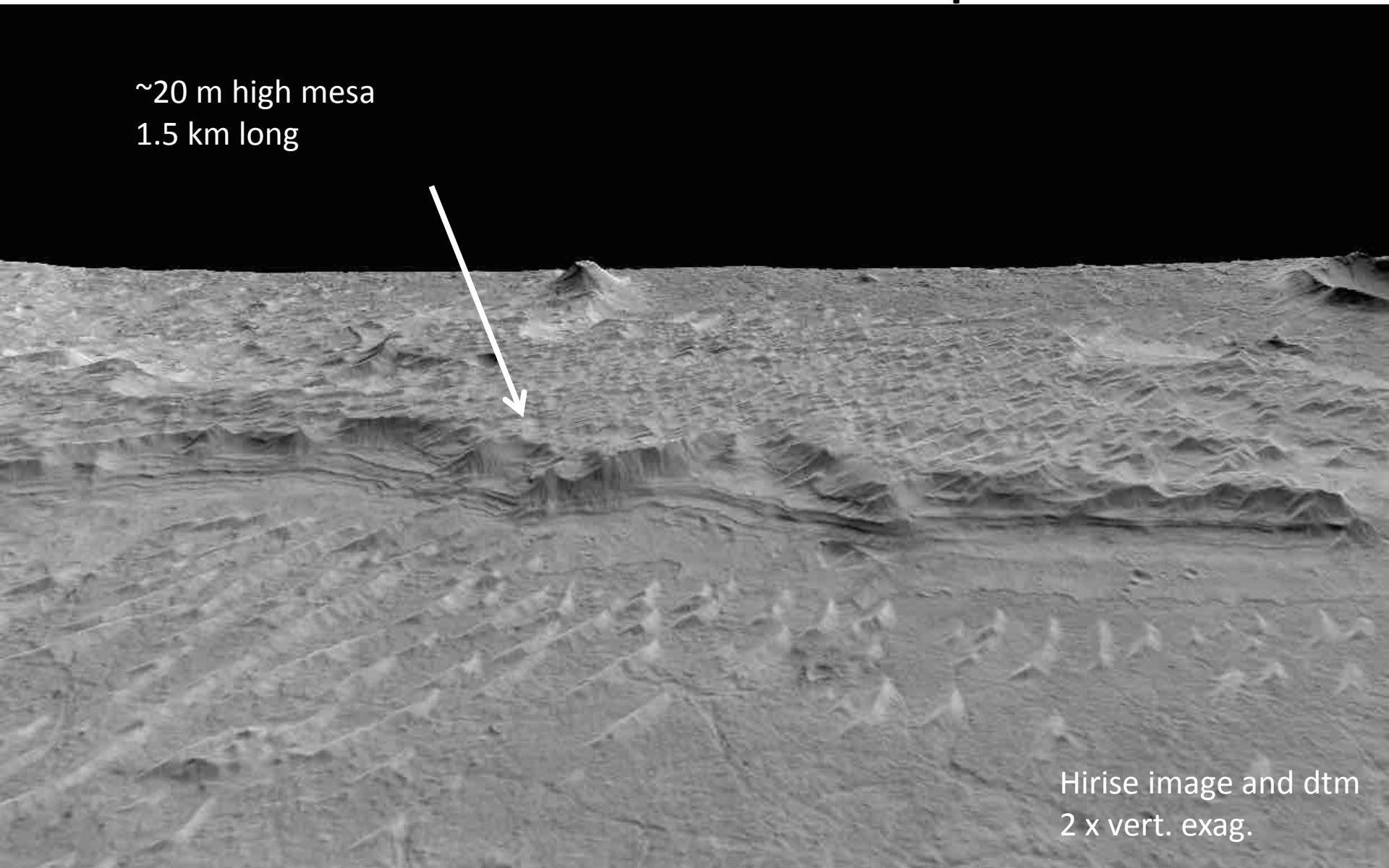

Key to ROI types:
1 - Layering in smooth plains unit exposing lacustrine/pro-delta stratigraphy.
2 - Deltaic deposits.
3 - Mounds/rounded buttes
Next slide
Deltaic deposits.
1.5
Km

Delta strata overlie basin-floor deposits

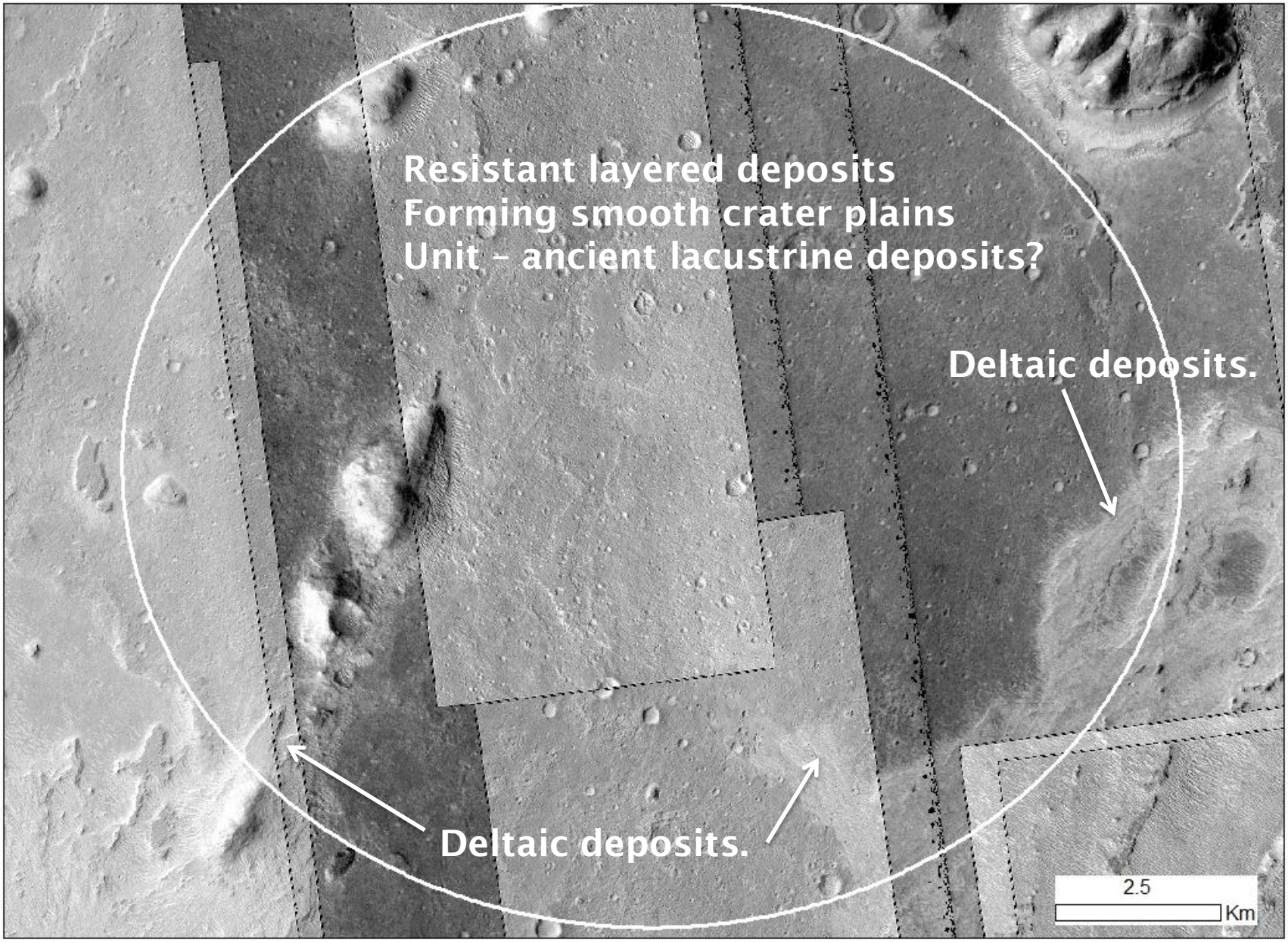



Detail of centre-east ellipse: Evidence of Recent Exposure?
Eroding layers on basin-floor
- lacustrine deposits?
Retreating scarp
0.7
Km

Beautiful layered deltaic deposits nearby, between the two ellipses



Secondary Ellipse



Hypanis – key points 1

- **Late Hesperian aged, sedimentary rocks throughout the area**
  - **Therefore, lots of science targets**
- **Clear fluvio-deltaic context**
  - **Excellent aqueous geological setting**
- **Sourced from extensive fluvial system – likely long duration of activity and samples extensive geologic units**
- **Likely downstream association with low energy fine-grained pro-delta and lacustrine layered deposits**
  - **High rates of sedimentation**
  - **Good biomarker preservation potential**

Hypanis – key points 2

- **Extensive layered sedimentary rocks associated with geomorphic features**
- **One of several deltaic systems in the region – this could be a representative example of widespread, ancient deltaic systems at Chryse basin margin**
- **No downstream topographic boundary – what created the basin – a large Chryse lake/sea???**

Potential to investigate and cache a large variety of sedimentary rocks from an ancient aqueous environment. Possible volcanic rocks as float?

What is the bath-tub that ponded water?

Was the Chryse basin the bathtub?

HYPANIS: A large, enigmatic deltaic-lacustrine system

Mars 2020 Mission and Decadal Priority Science Factors

	Environmental Setting for Biosignature Preservation and Taphonomy of Organics								Type 1A & 1B Samples: Aqueous Geochemical Environments indicated by Mineral Assemblages									Type 2 Samples: Igneous		Context: Martian History Sampled, Timing Constraints				
	Deltaic or Lacustrine (perennial)	Lacustrine (evaporitic)	Hydrothermal (<100°C) surface	Hydrothermal (<100°C) subsurface	Pedogenic	Fluvial/Alluvial	No diagenetic overprinting	Recent exposure	Crustal phyllosilicates	Sedimentary clays	Al clays in stratigraphy	Carbonate units	Chloride sediments	Sulfate sediments	Acid sulfate units	Silica deposits	Ferric Ox./Ferrous clays	Igneous unit (e.g, lava flow, pyroclastic, intrusive)	2nd Igneous unit	Pre- or Early-Noachian Megabreccia	Oldest stratigraphic constraint	Youngest stratigraphic constraint	Stratigrapy of units well-defined	Dateable surface, volcanic (unmodified crater SFD)
Hypanis	●	~	~			●		~		○								~			LN	EA?	●	~

Delta deposits in ellipses; likely pro-delta deposits cover ellipse

Hydrated mineral signatures from aqueously-altered materials or minerals precipitated when lake dried up?

Fluvio-deltaic deposits exposed in ellipse and at ellipse edge

Multiple retreating scarps suggest potentially-recent exposure

Hydration signature from CRISM nearby in deltaic sediments (1.9 micron water signature)

Igneous clasts in deltaic sediments ?

Based on Fluvio-deltaic deposit formed in early Hesperian

Based on crater retention ages

Well-defined stratigraphy mapped in basin

Possible ash beds outside ellipse?

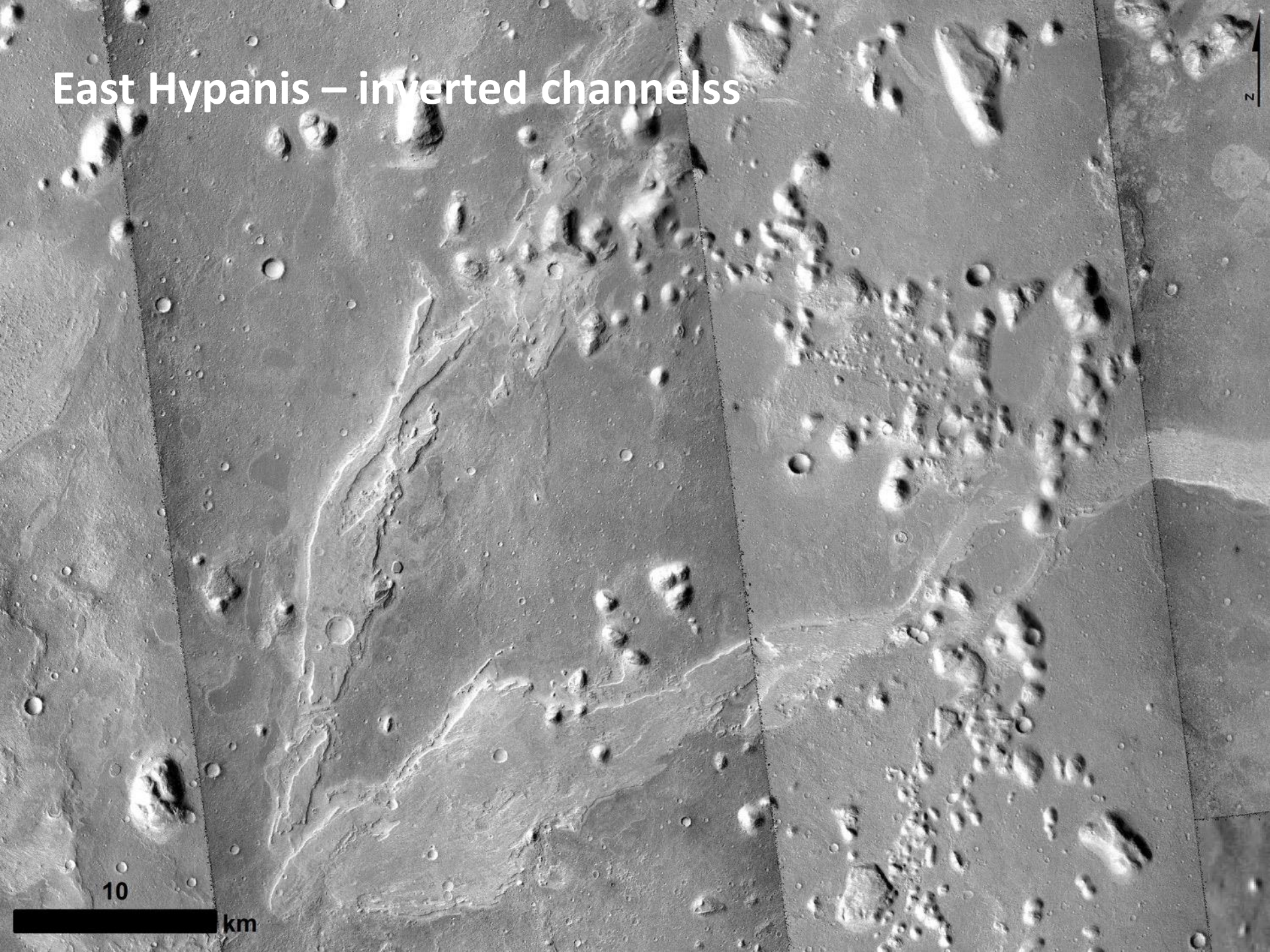
- **TRN required? *No***

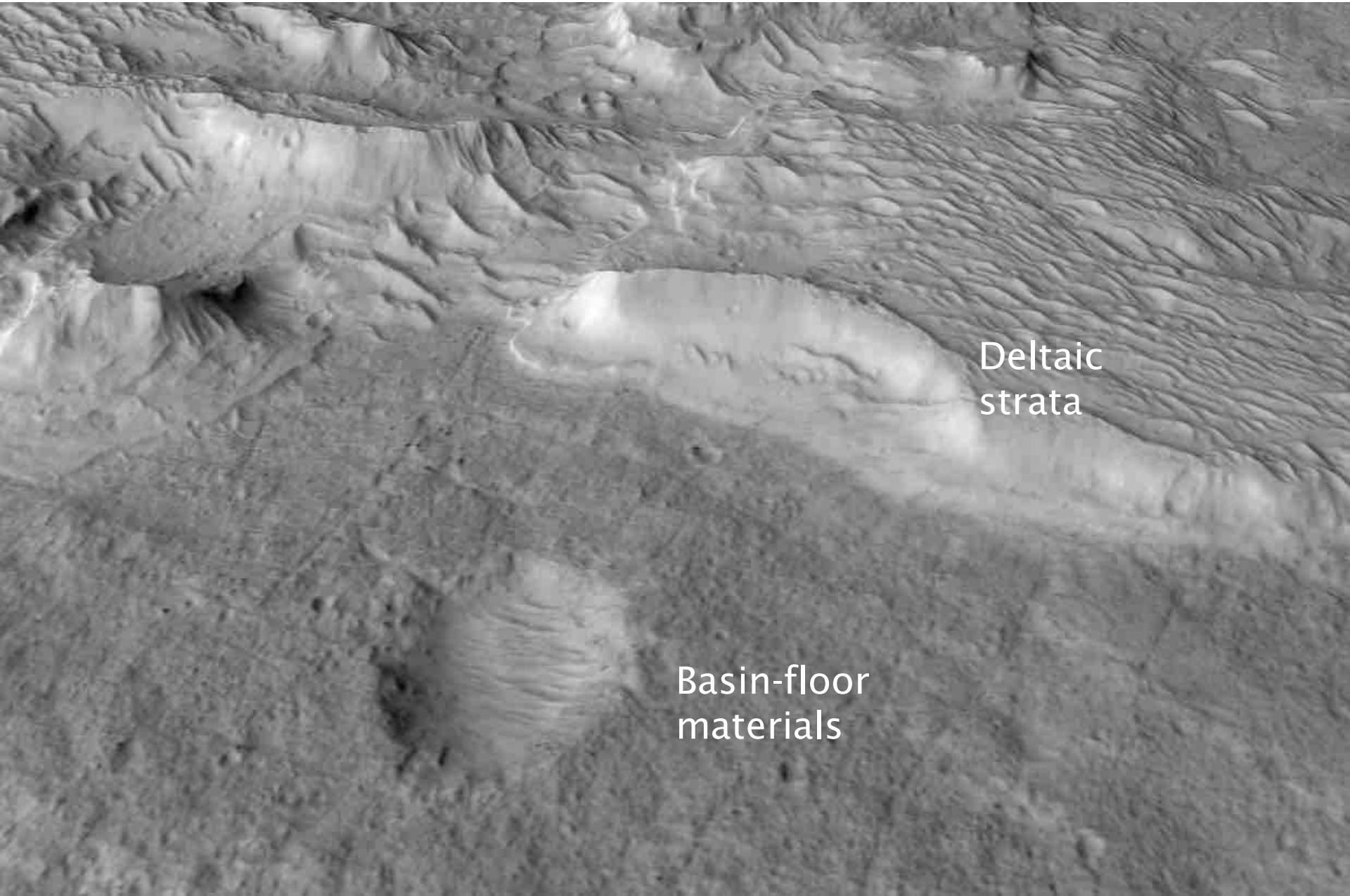
Backup

Why is Hypanis a delta system?

- Hypanis – why is it a delta and not an alluvial fan?
- In an alluvial fan, sedimentation occurs at entry point and builds a semi-circular deposit with the avulsion node fixed at the entry point
- In deltas we can see channel-lobe transitions and avulsion nodes downstream of entry point

East Hypanis – inverted channelss




Deltaic
strata
Basin-floor
materials